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ANNUAL REPORTS

OF THE

WAR DEPARTMENT

FOR THE

FISCAL YEAR ENDED JUNE 30, 1904.

VOLUME IX.

SUPPLEMENT TO THE REPORT OF THE CHIEF OF ENGINEERS.

REPORT OF THE MISSISSIPPI RIVER COMMISSION.

WASHINGTON:
GOVERNMENT PRINTING OF
1904.

ARRANGEMENT OF THE ANNUAL REPORTS OF THE WAR DEPARTMENT FOR THE YEAR ENDED JUNE 30, 1904.

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- Chief of Staff.
- The Military Secretary.
- Inspector-General.
- Judge-Advocate-General.

Volume II.........**Armament, Transportation and Supply:**
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ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1904.

OFFICE MISSISSIPPI RIVER COMMISSION,
FULLERTON BUILDING,
St. Louis, Mo., June 30, 1904.

SIR: The Mississippi River Commission has the honor to submit this its annual report for the year ending June 30, 1904.

The act of June 28, 1879, by which the Commission was created, defined its duties as follows:

> To direct and complete such surveys of said river, between the Head of the Passes near its mouth to its headwaters as may now be in progress, and to make such additional surveys, examinations, and investigations, topographical, hydrographical, and hydrometrical, of said river and its tributaries, as may be deemed necessary by said commission to carry out the objects of this act. * * * To take into consideration and mature such plan or plans and estimates as will correct, permanently locate, and deepen the channel and protect the banks of the Mississippi River; improve and give safety and ease to the navigation thereof; prevent destructive floods; promote and facilitate commerce, trade, and the postal service; * * *

Under the authority of this act and subsequent laws relating to the subject, surveys and observations have been carried on and works of improvement under the authority and direction of laws making appropriations for that purpose have been undertaken and executed. The original project contemplated the permanent location and deepening of the channel by engineering works for the contraction of the low-water width where necessary, the protection of the banks against caving, and the confinement of the discharge at flood stages by levees. These works were prosecuted with effect for a number of years in two selected parts of the river, known as Plum Point reach and Lake Providence reach, and with highly beneficial results in the improvement of the channel in those reaches. But the work done in them, while demonstrating the soundness of the theory upon which it was based, also demonstrated that the general improvement of the channel by contraction and revetment works would necessarily consume too long time and involve too great expense to meet the needs of commerce. It happened also, fortunately, that as that fact became apparent the progress of engineering skill and invention had reached the point at which dredging machines became possible of such power and efficiency as to hold out the hope that an immediate and economical solution of the problem of deepening the channel for navigation might be found in the opening and maintenance of channels across the obstructing bars at low water by means of dredging. After studies and experiments extending over several years this method of improvement of the low-water channel was adopted and has been applied with success. The history of the work from the beginning, and of the experiences which led to this change of plan and the reasons for such change are fully detailed in former reports.

The general project under which the work of the Commission has been conducted for several years past, and which is proposed for the year to come, may be stated as follows:

1. Continuation of surveys; preparation and publication of maps; maintenance of gauges; the recording, tabulation, and publication of gauge readings, and the taking and recording of discharge measurements and other observations.
2. The building, extension, and repair of levees.
3. The building, maintenance, and operation of dredge boats.
4. The repair of existing works for the improvement of the channel, the preservation of harbors, the prevention of cut-offs, and the security of levees.
5. Other miscellaneous details incident to the execution of the general project.

All of which will be specified in detail in what follows.

APPROPRIATIONS AND ALLOTMENTS.

By the sundry civil act approved March 3, 1903, the sum of $2,000,000 was appropriated for continuing improvement of Mississippi River from Head of Passes to the mouth of the Ohio River, including salaries, and clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission. The amount thus appropriated was allotted, on the recommendation of the Commission, as follows:

Mississippi River Commission	$27,000	
Surveys, gauges, and observations	65,000	
Dredges and dredging	286,000	
		$378,000
FIRST AND SECOND DISTRICTS.		
Repair of revetment work:		
Plum Point reach	69,000	
Hopefield Bend	99,000	
Care, repair, and renewal of plant	60,000	
Levees	325,000	
Surveys	5,000	
Harbor of Helena, Ark	5,000	
Harbor of Memphis (including Wolf River)	8,000	
		571,000
THIRD DISTRICT.		
Repairs and extension of revetment work	135,000	
Care, repair, and renewal of plant	77,000	
Levees	403,500	
Surveys	5,000	
Harbor, Greenville, Miss	25,000	
		645,500
FOURTH DISTRICT.		
Repairs and extension of revetment work at Bondurant and Kempe for protection of levees	69,000	
Care, repair, and renewal of plant	47,000	
Levees	271,500	
Surveys	6,000	
Harbors of Natchez and Vidalia, Mississippi and Louisiana	12,000	
		405,500
		2,000,000

By the sundry civil act approved April 28, 1904, the sum of $2,000,000 was appropriated for continuing improvement of Mississippi River from Head of Passes to the mouth of the Ohio River, including salaries and clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission. The amount thus appropriated was allotted, on the recommendation of the Commission, as follows:

Mississippi River Commission	$30,000	
Surveys, gauges, and observations	50,000	
Dredges and dredging	307,000	
		$387,000
FIRST AND SECOND DISTRICTS.		
Surveys	5,000	
Repairs to revetments at Fletchers Bend and Osceola bar, including quarrying of stone	100,000	
Hopefield Bend	120,000	
New Madrid	10,000	
Helena	10,000	
Plant	50,000	
Levees	310,000	
		605,000
THIRD DISTRICT.		
Surveys	5,000	
Repairs to revetment at Lake Providence and general repairs, including quarrying of stone	67,000	
Plant	20,000	
Longwood revetment	100,000	
Levees	380,000	
		572,000
FOURTH DISTRICT.		
Surveys	5,000	
Repairs of revetment at Bondurant	3,000	
Repairs of revetment at Kempe Bend	80,000	
Plant	38,000	
Levees	310,000	
		436,000
		2,000,000

By the act approved April 28, 1904, authority was given to the Secretary of War, as recommended by the Mississippi River Commission, to enter into contract or contracts for levee work upon the Mississippi River between Cairo and the Head of the Passes during the fiscal year ending June 30, 1905, to the extent of $1,000,000, to be paid for out of the appropriation for that stretch of the river authorized by the river and harbor act of 1902 for the fiscal year ending June 30, 1906, when the appropriation for the last-named fiscal year shall become available.

Pursuant to this act allotments have been made, upon the recommendation of the Commission, of sums for which contracts for levee work in the several districts may be made as follows, to be paid for out of the appropriation for the fiscal year ending June 30, 1906, when the appropriation for that year shall become available:

Upper St. Francis levee district	$15,000
Reelfoot levee district	15,000
Lower St. Francis levee district	140,000
Upper Yazoo levee district	70,000
White River levee district	70,000
Lower Yazoo levee district	150,000
Upper Tensas levee district	230,000
Lower Tensas levee district	110,000
Atchafalaya levee district	40,000

Lafourche levee district	$40,000
Pontchartrain levee district	90,000
Barataria levee district	15,000
Lake Borgne levee district	15,000
	1,000,000

Details of the expenditure of these allotments are appended hereto.

Two changes have occurred during the year in the membership of the Commission. Benjamin M. Harrod was appointed member of the Isthmian Canal Commission and was succeeded by Henry B. Richardson, qualified March 31, 1904; and Henry L. Marindin died March 25, 1904, and was succeeded by Homer P. Ritter, appointed April 14, 1904, and qualified April 20, 1904.

Three meetings of the Commission have been held during the year—the ninetieth, which was held on board the steamer *Mississippi* during the annual low-water inspection of the river from November 7 to 17, 1903, inclusive; and the ninety-first, which was held on board the steamer *Mississippi* during the annual high-water inspection of the river from March 10 to 18, 1904, inclusive; and the ninety-second, which was held at the office of the Commission at St. Louis from June 27 to 29, 1904.

SURVEYS AND MAPS.

The field work of the surveys comprises secondary triangulation, precise levels, topography, and hydrography. The secondary triangulation now covers the entire river from the Head of the Passes to the headwaters of Lake Itasca, a distance by river of about 2,347 miles. The triangulation follows the river to Aitkin, Minn., about 1,086 miles above Cairo. From Brainerd, Minn., about 55 miles below Aitkin, it is carried directly across country to Lake Itasca, and thence down the river to Lake Bemidji. From Lake Bemidji a base line, whose length and azimuth are accurately determined, has been carried along the railroad to Aitkin, thus forming a loop. This base line forms the basis of the topography and hydrography work along the river. The precise levels also cover the entire river and generally follow the same lines as the triangulation, but extend down to the end of the jetties at the mouth of South Pass.

Topography and hydrography.—The topography and hydrography of the river are completed from the Head of the Passes to Pokegama Dam, Minn., a river distance of about 2,230 miles. This work is also completed over the Itasca Basin and a portion of the river in that vicinity. Numerous surveys and resurveys of portions of the river have been made during the past year for special purposes, all of which are described in the report of the Secretary, hereto annexed.

Published maps and charts.—Detail maps Nos. 213 to 218, inclusive, were published to a scale of 1:10,000. This extends this series from Minneapolis, Minn., to about 10 miles below Little Falls, Minn., 992 miles above Cairo. A title sheet and an index map in two sheets for the series of detail charts from Cairo to Minneapolis were published. Maps Nos. 131 to 135, inch to the mile series, were published. These extend to the lower limits of the city of St. Paul, Minn. A map of the St. Francis Basin, upon a scale of one-half inch to the mile, two sheets, was published. A second edition of 500 copies of the Itasca Basin map, in colors, was published.

GAUGES.

Permanent gauges.—There are 38 permanent gauges, comprising 17 established by the Commission and 21 received by transfer from the U. S. Engineer Office at Vicksburg in 1901. They are distributed as follows: 25 on the Mississippi River from St. Louis, Mo., to Fort Jackson, La.; 1 on the Atchafalaya River; 1 each on the Arkansas, Cumberland, Tennessee, and St. Francis rivers; 3 on the Red River; 3 (including Cairo) on the Ohio River; 2 on the White River. The gauges established by the Mississippi River Commission are maintained by allotments from the appropriation for improving Mississippi River from Head of Passes to the mouth of the Ohio River, and the others by allotment from the permanent appropriation for gauging the waters of the Mississippi River and its principal tributaries, established by acts of August 11, 1888, and June 13, 1902. A description of these gauges is printed in the supplement to the Report of the Chief of Engineers for 1902, pages 52 to 59. The permanent gauges have been twice inspected during the year, gauges and bulletins being repaired and left in good order.

The highest and lowest readings on the permanent gauges during 1903 with the previous highest and lowest for comparison, the highest readings on the gauges on the tributaries for 1904 to June 30, and a hydrograph showing the daily stages of the main river from Cairo to Fort Jackson from June 1, 1903, to May 31, 1904, are given in the report of the Secretary, appended hereto.

A new inclined gauge of concrete, with a steel beam embedded, has been constructed on the levee slope at Memphis, Tenn. The graduations and figures have been marked in the steel of the St. Louis gauge. The gauges at Cairo and Memphis will be marked in a similar manner next season. The high water of 1903 at St. Louis, which read 38 feet, has been permanently marked on the gauge. A gauge has been maintained at Aitkin, Minn., in connection with the survey of the upper Mississippi.

High-water gauges.—The high-water gauges are 185 in number, distributed on the Mississippi River, from Cairo to the Head of the Passes, about 5 miles apart. These gauges are read at times of highest water only, and supplement the permanent gauges in determining the high-water slope of the river. They were inspected and put in order previous to the high water this spring. The maximum readings on these gauges during the high water of 1904 are given in the report of the Secretary, together with a profile of the main river from Cairo to the Head of the Passes.

Tide gauges.—The tide gauges at Biloxi, Miss., and East Bay, La., have been maintained in good order and continuous records for the year secured. The staff gauges were connected with their bench marks by precise levels in January, 1904. The reduction of the records since 1899 is now in progress, and the results will be published when the reduction is completed.

Discharge observations.—During the high water of June, 1903, the discharge of the Mississippi River was measured at Grafton and Thebes, Ill. The discharge of the Arkansas River at Little Rock, Ark., was measured about the same time. All these discharges were taken at the highest stages reached. The results were published in Table No. 7, on pages 111, 112, and 119 of the Supplement to the Report of the Chief of Engineers for 1903. During the low-water season of 1903 the discharges of the Tennessee and the Cumberland rivers were measured at the lowest stage reached, which was below the prescribed discharge stage. The prescribed stage for low-water discharge measurements on the Mississippi was reached at Columbus, Ky., for part of one day, December 20, when a reading of 2.99 was recorded; and at Carrollton, La., from December 28 to 31, the minimum reading being —0.1.

During the high water of 1904 the discharge of the Mississippi River was measured at Thebes, Ill., Columbus, Ky., Helena and Arkansas City, Ark., Vicksburg, Miss., and Red River Landing and Carrollton, La. The discharge of the Atchafalaya was measured at Simmesport, La. All these discharges were taken at the highest stages reached at their respective localities. The results of these measurements are set out in the report of the Secretary hereto appended.

DREDGES AND DREDGING.

Project.—In 1896 the Mississippi River Commission adopted a project for obtaining and maintaining by means of dredging a channel in the Mississippi River below Cairo, with a width of 250 feet and a depth of at least 9 feet throughout the year, except when the river is closed by ice. This project provided for the construction and operation of 7 hydraulic dredges by the 30th of June, 1900, and, provisionally, for the construction of two others, if found necessary.

The first dredge, the *Alpha*, was built from plans prepared by the dredging committee of the Commission, and was in the nature of an experiment. While many changes in this boat were afterwards found necessary, it nevertheless demonstrated the efficiency of hydraulic dredges for the work proposed. The next step was to define in general terms the conditions which the dredges must fulfill, leaving to the builders the details of the design. Following this course three dredges were built. Experience was constantly gained until a point was reached where it was possible to outline with greater accuracy nearly all the details of construction. Under such specifications two more dredges were built. Under still more rigidly drawn specifications another, the seventh, a self-propelling dredge, was placed under contract in 1898. This dredge was completed and delivered to the United States in August, 1900. The eighth and ninth dredges, also self-propelling, were placed under contract in June, 1899, and were completed and delivered to the United States in July, 1901. In June, 1902, the *Alpha* having become unserviceable, the construction of a tenth dredge, to be self-propelling, was decided upon. Plans, specifications, and drawings have been prepared, the work advertised, and bids received, which are now being considered.

The names of the dredges and the order of and dates of their construction are follows: The *Alpha*, July, 1895; the *Beta*, April, 1896; the *Gamma*, August, 1897; the *Delta*, August, 1897; the *Epsilon*, March, 1898; the *Zeta*, March, 1898; the *Iota*, October, 1900; the *Kappa*, July, 1901; the *Henry Flad*, July, 1901. The tenth of the series, to be built during the coming season, will be named the *B. M. Harrod*. Details of condition, repairs, and operation of the dredges will be found in the report of the Secretary hereto appended.

The season's operations.—During the low-water season of 1903 six dredges, the *Delta*, the *Epsilon*, the *Zeta*, the *Iota*, the *Kappa*, and the

Henry Flad, were in commission. The *Beta* was returned to the fleet on September 28 by the officer in charge of the work at South Pass, and did not take the field after that date, while the *Gamma* was not put in commission during the season. The dredges were assigned to different stretches of the river. Three survey parties were kept in the field, and surveys were made of all bars where trouble was anticipated. Frequent surveys were made of those bars where dredging was done, to observe the effect of the dredging. These surveys served to determine the areas of shoal water and to enable the location of the channels to be intelligently made. Frequent inspections were made of that part of the river where shoals are known to exist, and all crossings sounded. The greatest possible publicity was given to information obtained, and all channels were located by easily distinguishable marks.

The river did not reach a stage requiring extensive dredging until about December 5, on which date a stage of 10 feet on the Cairo gauge was first reached. At the beginning of the season it was expected that the high water of the spring of 1903 would result in the formation of many obstructing bars, and that conditions requiring extensive dredging operations would early develop. The dredges were accordingly prepared for service and the survey and inspection parties organized early in August. Four dredges, the *Delta*, the *Zeta*, the *Iota*, and the *Kappa*, took the field during that month, and two more, the *Epsilon* and the *Henry Flad*, were sent out early in September. During the early part of the season these six dredges were operated wherever it was possible for them to work; but, owing to the high stages prevailing, they were unable to work to the best advantage, except at Peters (272), where the bar was high and the dredge was accordingly able to make a deep cut, in which the channel remained throughout the season. In the latter part of October the *Epsilon* and the *Zeta* were withdrawn from the field, as there was no work for them to do, and it was believed that the other dredges would be able to handle any situation likely to arise so late in the season. The *Kappa* had been retired in September on account of an accident to her main engine, and during November the three remaining dredges, the *Delta*, the *Iota*, and the *Henry Flad*, were successively retired, so that at the end of the month all the dredges were at the fleet, the *Delta* and the *Henry Flad* being kept in commission ready for use if needed.

Up to this time a channel of 10 feet or over had been maintained, except at Peters, where 9½ feet was found at the beginning of the season. The river was then rising at Cairo, and the season was considered closed, the general belief being that the rise then in progress was the beginning of the usual midwinter high water. About the 1st of December, however, the weather in the Ohio and Mississippi valleys turned suddenly cold and an unexpected, rapid, and continuous fall set in on the 3d, the river dropping to a stage of 2.8 at Cairo on the 20th. An even more abrupt rise followed, reaching a stage of 9.7 on the 25th and 11.6 on the 29th. The corresponding stages at Memphis were 6 on December 4, 0.9 on the 23d, and 5.6 on the 31st. On December 9 the inspection party found a depth of 8½ feet at the foot of island 21 (131), and the *Henry Flad* was at once ordered into the field, followed within a day or two by the *Delta* and the *Kappa*. The *Iota* was put in commission, but was not sent into the field on account of the shortage of coal.

At this time there remained on hand about 40,000 bushels of coal for dredging operations, or thirty-five days' supply for one dredge. Thirty-five thousand bushels more had been ordered from the coal company, but they were unable to make any deliveries until the 28th on account of the suspension of navigation in the Ohio River by ice and low water. Twenty-two thousand bushels were secured at Memphis, but it proved impossible to obtain more, as none of the coal companies was able to bring any coal out of the Ohio, and no arrangements for handling coal from cars could be made. On the 13th the *Henry Flad*, on her way up the river, sank a full barge at Craighead Point (171) and lost nearly three days waiting for a new supply. On the evening of the 21st a boat containing about 10,000 bushels, which had that morning been delivered to the *Kappa*, was sunk at Presidents Island (235) by the steamer *James Lee* and the contents lost. The *Kappa* was then forced to retire from the field, leaving only the *Delta* and the *Henry Flad* in operation for the rest of the month.

Under these circumstances the operations of the dredges did not keep pace with the falling of the river, and the depths were reduced below 9 feet on a number of the bars, and remained in that condition for periods of from six to sixteen days on the various bars, between December 7 and 26, 9 feet and over being restored on all bars by the latter date. Between the 15th and the 26th navigation above Cairo, on both the Ohio and Mississippi rivers, was entirely suspended by ice and low water, the larger type of steamers having been compelled to suspend operations as early as the 5th. On the 13th ice began running in the river below Cairo, and a gorge was formed at Columbus on the 16th, lasting two or three days. Except for this interruption, however, regular packets and numerous tows of lumber and logs ran between Memphis and Cairo, and the packets below Memphis continued to run throughout the month. It is not known that any boat grounded in the channel during the low stage, though several ran on the bars outside of the channel limits. With the exceptions above stated, depths of 9 feet or more were maintained over all the bars.

The failure to maintain the prescribed depth on all bars is not believed to indicate any inherent weakness in the project for maintaining below Cairo a channel 9 feet in depth by means of dredging, which has proved in past seasons able to cope successfully with lower water than was met with this year. The sudden fall came when the season was considered closed, and the operations of the fleet were seriously hampered by the scarcity of coal, numerous accidents, severe storms, and freezing weather. Those dredges which it was possible to operate readily opened channels through the bars at which they worked, indicating that had it been possible to put more dredges in the field a channel of the required dimensions could have been quickly secured and maintained. A list of the bars and a brief statement of the work done at each will be found in the report of the Secretary, appended hereto.

The season's experience has emphasized several important facts relating to the maintenance of a deepened low-water channel by means of dredging. Of these may be mentioned first the additional evidence afforded of the practicability of the project. There was no failure of any dredge to make a channel speedily and successfully where it had the opportunity to work. In some cases unusual results were accomplished. At the opening of the low-water season the shoalest point below Cairo, as shown by the surveys, was at Peters Crossing, 272 miles below Cairo, where the bar was 4 feet and more above low water, extending completely across the river with a least width between low-water contours of nearly half a mile. The dredge *Delta* began work at that place on August 30, and continued, with some interruptions for repairs, until September 9, when the work was completed. The dredging was done with a deep cut, and although the rate of advance was slow, the results were excellent; a broad, deep channel being formed following the dredged cut, which remained in excellent condition throughout the season. During the subsequent extraordinary low water in December the depth fell to 8 feet above the cut, while in the cut itself the depths were 10 to 12 feet and over.

The sudden and unexpected fall of the river in December showed the necessity of some more ample provision for such emergencies. The number of dredges available ought to be increased and the Commission recommends the construction of another one to follow the *B. M. Harrod* as soon as funds for that purpose shall be available.

This experience also suggests with renewed emphasis the importance of continual striving for higher degrees of excellence in design and construction of machinery. The dredge boats were all well built, up to the best known and tried standards of the time (except the dismantled *Alpha*), and were all good and effective machines. But the knowledge gained by the extensive work on the bars, supplemented by systematic and careful tests of capacity and operation, has led to the elimination of defects and progressive improvement of construction. The last three built of the dredge boats now in the service are believed to represent the highest level of excellence for the particular work for which they are used that has been reached in the art. It will contribute to the certainty of complete and uninterrupted maintenance of the improved channels to bring the fleet not only to a sufficiency in number to anticipate such freaks of behavior of the river as occurred in December last, but to the highest attainable perfection of design and construction. That confidence in the permanent and uninterrupted continuance of a good channel for navigation which is indispensable to meet the demands of commerce will not be secured until it shall have been demonstrated through a series of years not merely that obstructing bars can be removed by dredging, but that the Government will certainly be at all times prepared with a plant sufficient to do the work under all conditions that can arise.

SURVEY FOR 14-FOOT WATERWAY, MISSISSIPPI RIVER, FROM THE MOUTH OF THE ILLINOIS RIVER TO ST. LOUIS, MO.

A full history of this survey up to the date of the last annual report is published in the supplement to the Report of the Chief of Engineers for 1903, page 68. During the season of 1903 a party was put in the field to supplement the work of the previous year. The work done by this party included levels and topography on the large islands, omitted in 1902, and on the lowlands east of the river, from the Merchants Bridge to Wood River; also topography of the Columbia bottoms where not covered by previous surveys; topography and levels between the Mississippi and Missouri rivers, in the vicinity of Portage, Mo.; soundings in the Missouri River for 2 miles up from the mouth, and the location of dikes in the river between Grafton and St. Louis. The discharge of the Illinois River and of the Mississippi both above and below the mouth of the Illinois were measured and eight borings made in the river bed to rock, the boring apparatus being mounted on a pile driver.

The work of reducing and platting the field notes has been in progress since the close of the field work. The finished maps will cover thirteen sheets, on a scale of 1:4,800.

Attention is called to the following reports which accompany the report of the Secretary, hereto appended.

Report of Assistant Engineer Kivas Tully on gauges, discharge observations, reduction of physical data, and office publications.

Report of Assistant Engineer F. B. Maltby on dredging operations on the Mississippi River between Head of Passes and the mouth of the Ohio River, and care and repair of dredging plant.

Report by the same officer on efficiency tests of hydraulic dredges.

CHANNEL WORKS, BANK PROTECTION, AND HARBOR IMPROVEMENTS IN THE SEVERAL DISTRICTS.

First district, from Cairo, Ill., to the foot of Island 40 (220 miles).—Headquarters, Randolph Building, Memphis, Tenn. District officer: Capt. E. W. Van C. Lucas.

Construction works for channel improvement, protection of caving banks, and harbor work in this district are located at Columbus and Hickman, Ky., New Madrid and Caruthersville, Mo., and Plum Point reach, together with certain isolated works of low-water channel dikes at different points throughout this district.

Columbus, Ky., 21 miles below Cairo, left bank.—The work at this point was done in 1889 and 1890 and consists of 5 submerged dikes protecting about 2,200 feet of harbor front. No repairs have been made since, and while some minor work is desirable it is not at present absolutely necessary.

Hickman, Ky., 36 miles below Cairo, left bank.—The work at this point consists of 1,650 feet of continuous revetment placed in 1889, 1892, and 1894, to prevent caving along the lower portion of the town. Slight repairs were made in 1900 on account of injury to the revetment from local drainage. The work is now in good condition and nothing additional is at present contemplated.

New Madrid, Mo., 71 miles below Cairo, right bank.—This work consists of bank revetment, extending along the river front of the town, of continuous fascine mattresses 260 feet wide below low water, with riprap paving on the graded bank above low water. Nine hundred feet of revetment was constructed in 1893 and afterwards extended as follows: 700 feet in 1894, 500 in 1896, 1,573 in 1898, and 1,000 in 1900. The present effective revetment is 4,450 feet long and is in generally good condition excepting a few places near the low-water line which will require minor repairs whenever the river stage will permit. A recent change in the channel crossing just above the town threatens the upper end of the revetment work, which may have to be extended about 1,000 feet upstream.

Caruthersville, Mo., 110 miles below Cairo, right bank.—This work consists of spur dikes and continuous revetment for the protection of the caving bank in front of the town, the present effective length being 2,300 feet. This revetment is in good condition excepting at the lower end, where it is flanked by a deep cave, making a downstream extension advisable. There are indications of caving above the revetment, and an upstream extension may also be necessary.

Plum Point reach, 147 to 186 miles below Cairo.—This reach comprises about 67,400 feet of revetment for the protection of caving banks, the closure of the chutes behind Elmot bar and Island 30 with a brush and stone dam, the closure of Osceola and Bullerton chutes with pile dikes, and a levee along the left bank to confine the flood waters more closely to the river bed. The object of all these works was to increase the navigable depth at low water in a reach of river which had been noted for years for its obstructing sand bars. As a result the banks have remained practically fixed within the prescribed limits, and the navigable depth at low water has been increased to such an extent that little or no difficulty has been experienced in navigating this reach since the works approached completion.

At no time since the works were well under way has the navigable depth reached as low a point as it did nearly every low-water season prior to the construction of the rectification works. Dredging was done in this reach during two different low-water seasons in order to maintain the required depth of 9 feet.

During the past year work in this reach consisted of general repairs where woven-mattress revetment had been damaged or destroyed. At Daniels Point and Ashport Bend these repairs were of a minor character. It had been expected that the lower part of the Daniels Point revetment, which has been almost completely destroyed within the past two years, would have to be replaced, but it has become apparent within the last year that the revetment now in place will probably suffice to hold this bank in its present good condition, caving below having almost entirely ceased.

Ashport Bend has a continuous revetment about 16,450 feet long, which required minor repair work last season and is in generally good condition. Ten crib dikes were placed from the top of the paving to the top of the bank to prevent further scour above the paving, and willows were planted rather extensively with a view to inducing a natural growth to effect the same purpose.

Of the 17,300 feet of revetment at Fletchers Bend, 4,400 feet has been destroyed during the last two years and partially replaced with about 2,000 feet of fascine revetment. The work of the last season consisted in placing two mats, respectively 705 and 778 feet long, above and below the mat placed in 1902. There still remains a gap 2,500 feet long where the old work has been destroyed and which will be covered during the coming season with a new fascine mat. Below this break the old revetment will be reenforced where weakness is indicated, as far as funds will permit.

At the head of Osceola bar the 1895 mattress, originally 3,750 feet long, is almost destroyed. No funds were available for this locality during the past year. The old revetment below the 1895 work is apparently in good condition, although it is not exposed to current attack.

The lower Osceola and Bullerton bar revetment is continuous, about 14,300 feet long, and all in good condition. It was constructed in 1893–94 and has required no repairs since completion.

It should be noted that the excessive repairs in Plum Point reach are principally confined to the old style mattress work, which is deficient in width and weak in construction.

Abattis dikes.—These dikes are used for the purpose of closing secondary chutes and contracting the low-water channels by building up the sand bars. No allotment was made for work of this class during the past season, but a break in a dike built during the preceding season near Hathaways Crossing (183 R.) was repaired with the balance remaining from the previous year. Experience indicates that when properly placed these dikes are very effective in building up bars.

For further details concerning the first district see reports of Captain Lucas and Assistant Engineer Nolty, appended hereto.

Second district, foot of Island 40 to White River (173 miles).—Headquarters Randolph Building, Memphis, Tenn. District officer: Capt. E. W. Van C. Lucas.

This district includes the protection of caving banks and harbor work at Hopefield Bend and Helena, Ark., and at Memphis, Tenn., and also the dredging of Wolf River, Tenn.

Hopefield Bend, Ark., 227 to 230 miles below Cairo, right bank.—This revetment was originally 16,600 feet long, was constructed at various times between 1882 and 1889, and has been repaired from time to time since completion. The upper 6,300 feet has been destroyed and partially replaced with 2,600 feet of new fascine mats built last year. At the beginning of last season the destruction of old revetment, begun last year, had continued, and the project for the year contemplated the placing of about 4,000 linear feet of new revetment to cover the part most urgently in need of repair. Twenty-six hundred feet of complete new revetment 250 feet wide was placed in the gap, and 840 feet of mat 116 feet wide was placed about 900 feet below station 0. Channel mat No. 3, originally 900 by 254 feet, and built with especial care, was broken in sinking and the lower 765 feet lost, the cause of the break being primarily a heavy cave, causing several thousand tons of earth to fall on the mat while it was being sunk. This revetment has a present effective length of about 12,900 feet.

Wolf River, 230 miles below Cairo, left bank.—The part of this stream under improvement is a part of Memphis Harbor, and its improvement consists of dredging for the purpose of maintaining a navigable channel during the low-water season from its mouth 2¼ miles upstream to the county bridge. During the past season 52,340 cubic yards of earth and 153 snags and logs were removed and the channel depth maintained, permitting navigation throughout the season excepting for a few days when the railroad transfer boat grounded and blocked the channel. To maintain this channel depth dredging will be required during each low-water season.

Memphis Harbor, 230 to 232 miles below Cairo, left bank.—The work along the Memphis front embraces the protection of 14,800 linear feet of bank by means of spur and continuous revetment, the upper portion of which is covered by a sand bar which encroaches somewhat upon the levee front of the city. The area of this bar between Wolf River and the levee front is about 100 acres at low water, of which 12 acres is above water at the 25-foot stage. The recession of the bank in Hopefield Bend has caused a movement upstream of the channel crossing from Hopefield Bend to Memphis, the result of which is a cutting away of the bar, a strip having an average width of 50 feet having been lost during the last year. It is believed that the progress of this bar downstream has been checked and that it is approaching a state of equilibrium which will be maintained as long as the present bank line in Hopefield Bend is held. The revetment along the Memphis front is in good condition, no repairs were made during the past season, and none are contemplated for the coming season. Its present effective length is 9,900 feet.

Helena, Ark., 306 miles below Cairo, right bank.—The revetment work at this place consists of the protection of 4,900 linear feet of river bank in front of the city, of which 3,500 feet is continuous revetment and 1,400 dike work. The caving or sloughing off at very low stages continued during the past season to a much greater extent than heretofore, and the levee is now dangerously threatened. The available funds were insufficient to do much work during the past season, and as only $10,000 is available for the coming year it is probable that the local levee boards will have to assist in doing the necessary work, which will probably consist of a short levee loop and mattress revetment between spurs.

The condition of the plant belonging to the first and second districts was very much improved by the beginning of the last working season, and revetment operations were carried on to the extent possible with available funds, which, however, were insufficient for the repair work actually needed, much of which had to be left till the coming season.

For further details concerning the work in the second district see reports of Captain Lucas and Assistant Engineer Rees herewith.

Third district, from White River to Warrenton, Miss. (214 miles).—Headquarters, Randolph Building, Memphis, Tenn. District officers: Capt. Chas. L. Potter, July 1 to 7, 1903, and Capt. E. W. Van C. Lucas, July 7, 1903, to June 30, 1904.

This district includes the works of improvement at Lake Bolivar front, Ashbrook Neck, and Greenville Harbor, Mississippi, and Louisiana Bend, Lake Providence revetment, and Delta Point, Louisiana. The operations of the past year included repairs to the revetments at Lake Bolivar front, Ashbrook Neck, Greenville Harbor, and Lake Providence revetment.

Lake Bolivar front, 417 miles below Cairo, left bank.—The revetment at this point was built to hold a bank the caving of which threatened a levee extending across between the head of Lake Bolivar and the bank of the river, the destruction of which would have resulted in the abandonment of a large area of highly cultivated land. The original work constructed in 1888 and 1889 consisted of 4,200 linear feet of bank revetment, of which 3,775 feet is now effective. Slight repairs have been necessary at different times to the upper bank pavement, and the work during the past season was of this character and not extensive. The revetment is in good condition, and with the exception of possible minor repairs no work is contemplated for the coming season.

Ashbrook Neck, 446 miles below Cairo, left bank.—The object of the work at this point was to prevent a threatened cut-off which would have disturbed the regimen of the river for a long distance above and below and brought disaster to towns, levees, and other works along the river banks. Work was begun in 1890 and continued at intervals until 1895. Repairs have been made from time to time in the upper bank paving and with reenforcing mats where the original revetment has shown signs of weakness. The future maintenance of this work will involve minor repairs to the bank paving and the reenforcing of the remaining 2,000 feet of old woven mats, which last, however, is not urgent.

The present condition of the revetment is good.

Greenville Harbor, 478 miles below Cairo, left bank.—This work has for its object the rectification of the bank to prevent the encroachment of the river on the town of Greenville, and also to prevent the destruction of the controlling levee line which protects the Yazoo Basin from overflow. During the twelve years from 1882 to 1894 the recession of the bank in the Greenville Bend amounted to 4,000 feet. This work was begun in 1887, when 10 submerged dikes were placed. The plan was changed to continuous revetment in 1891, and 14,500 feet of revetment have been placed, of which 12,100 is at present in effective condition. The work of the past season included the placing of one fascine mat 750 feet by 225 to reenforce the old revetment and some minor repairs to bank paving. Since the completion of this work the bank line has been effectually maintained. The revetment is in good condition, and there is no apparent need of any repair work during the coming season.

Lake Providence reach, 517 to 552 miles below Cairo.—Prior to the improvement work this reach presented the most serious obstructions to low-water navigation of any portion of the river below Cairo, except perhaps the Plum Point reach. The depths were often as low as 4½ to 5 feet on the crossings. It was therefore selected by the Commission as one of the reaches where a project for systematic improvement should be carried out. The works in this reach resulted in a marked improvement in the channel depths, but they proved to be too light to long withstand the attacks of the floods. Revetment was for a time prohibited by Congressional enactment, appropriations failed, and the repairs and renewals deemed necessary to strengthen and hold the work already done could not be made, and in consequence of this the uncompleted works were badly wrecked. It may, however, be said that these works served a useful purpose by materially improving the navigation of the entire reach, which still continues better than it was before the work was begun. There has been but one low-water season since the works approached a stage of completion when the channel depth was not sufficient for the demands of navigation, and even during that season the depth was some 2 feet greater than the common low-water depths prior to the beginning of the improvement work.

Louisiana Bend, 522 miles below Cairo, right bank.—The revetment in this bend is part of the systematic improvement of Lake Providence reach. Work began in 1889 and was continued from time to time, as funds were available, until 1897. No extension or repair of this work has been made since then. The total length of the original work was 15,820 feet, of which about 4,000 at the lower end has been destroyed.

Lake Providence, 540 miles below Cairo, right bank.—The object of this revetment work was to control and hold the rapidly caving bank that threatened to destroy the town of Lake Providence and an important levee situated between the lake and the bank of the river, the destruction of which would have necessitated the building of a long line of new levee extending from Bunchs Bend around the lower end of Lake Providence, and would have resulted in the abandonment of several square miles of cultivated land, including a portion of the town of Lake Providence. It was begun in 1894 and continued during the following year, further extensions being made in 1899 and 1900, when the total length was 12,500 feet, practically all of which is still effective. Minor breaks have developed from time to time, and the revetment has been extensively reenforced with modern fascine mats, until only 2,200 feet of the original woven mat work remains unprotected.

The work of the past season included two channel mats 250 feet wide and respectively 800 and 920 feet long, and a pocket mat to reenforce the old revetment; and in addition some repairs to the bank paving. A break in the bank about 700 feet long developed last March, which probably involves a part of the old woven revetment, and which will be repaired during the coming season. In addition, the remaining unprotected woven revetment will probably be reenforced.

Delta Point, 598 miles below Cairo, right bank.—The object of this work has been to hold the point opposite Vicksburg, and to prevent recession of the channel downstream away from the harbor, and so aid in the improvement of Vicksburg Harbor, now in charge of the Engineer Department. Caving above the work has continued, and may require an upstream extension of the revetment in the near future. No work was done during the year and none is contemplated for the coming season.

For further details of work in this district, see reports of Captain Lucas and Assistant Engineer Hider herewith.

Fourth district, Warrenton, Miss., to Head of Passes, 607–1,060 miles below Cairo.—Headquarters, 3232 Prytania street, New Orleans, La. District officers: Capt. Chas. S. Bromwell, Corps of Engineers, U. S. Army, to May 27, 1904, and after that date temporarily in charge of Lieut. Col. H. M. Adams, Corps of Engineers, U. S. Army.

The works include the bank protection of Bondurant Chute, bank protection in Kempe Bend, improvement of the harbors at Natchez and Vidalia, and improvement of the harbor at New Orleans, La.

Bondurant Chute, 644 miles below Cairo, right bank.—This work was undertaken in order to prevent the destruction of the levee lying between the end of Lake Bruin and the bank of the river, no other location of the levee line being practicable in the immediate vicinity, and its abandonment involving the construction of a loop several miles long around and behind the lake. In addition to the cost of constructing this new line of levee to replace the old one, the abandonment of the latter would result in the exposure to overflow of a large amount of cultivated land.

This revetment consists of mattresses constructed of willow brush, and a few experimental ones built entirely of lumber, for the submerged portion, with upper bank paving of concrete. During the past year the revetment has been extended 188 feet downstream, making a total length of 2,295 feet. It is now in good condition and is considered a complete work, requiring only current repairs.

Kempe Bend, 658 miles below Cairo, right bank.—The object of this work has been to prevent further erosion of the bank line in Kempe Bend, which has already destroyed several lines of levee and nearly reached a final line, the destruction of which would necessitate a long line of new levee of extremely difficult and costly construction. The construction of a new line would also require a long period of time, and a break in the front line in the meantime would be disastrous to a large section of the country below Kempe. Work on this revetment was begun in 1899 and continued each season since that time until it now reaches a length of 7,593 feet of revetment in three detached places, 5,315, 1,395, and 883 feet, respectively.

During the past season the work consisted of replacing 2,670 feet of the original revetment placed in 1899, which had been destroyed by the unusually strong current during low water and consequent scour of the channel, and of revetting the bank for a length of 1,395 feet in front of an exposed salient of the levee about 1,200 feet above the main revetment. The conditions in Kempe Bend are somewhat unusual, there being but little current along the bank during high water, while at low water it is exceedingly swift. As a result high-water inspections of the work can give no precise knowledge of its condition, which will not be developed until the forthcoming low-water season. The extension and repair of this revetment will be required during the season.

Harbors at Natchez and Vidalia, Miss. and La., 688 miles below Cairo, left bank.—This work has consisted of the revetment of Giles Bend in order to prevent a threatened cut-off, which would destroy the harbors of Natchez and Vidalia and disturb the general regimen of the river for many miles above and below. This work now covers a length of 14,790 feet, and operations during the past season have been confined to the repair and maintenance of the existing revetment. All the work that has been placed has been effective in maintaining the bank line, but further extension of the revetment will be required. The levee built along the axis of Cowpen Neck in conjunction with this work is in fair condition, requiring only minor repairs. Since the flood of 1903, caving along the harbor front of the city of Natchez has become very active. Operations at this point have generally been carried on under special appropriations, and a continuance of these is recommended.

Junction of the Mississippi, Red, and Atchafalaya rivers, La., 764 miles below Cairo.—The improvement in this locality consists in the maintenance of mattress sill dams in the Atchafalaya River for the purpose of preventing the enlargement of that stream, and dredging the low-water channel of Old River for the purpose of maintaining an adequate depth between the Mississippi, Red, and Atchafalaya rivers.

The original sills were placed in 1887–88, and since that time no enlargement of the Atchafalaya has been observed. The dams are apparently in good condition, and beyond slight repairs to maintain them, no further work is contemplated in this section.

During the past season the depth of water in lower Old River was such that no dredging was required at that place. The physical changes in this vicinity are carefully measured by means of frequent surveys, as it is important to ascertain promptly any tendency to enlargement in the bed of Old River or at the head of the Atchafalaya. The survey of this year shows but little change from those of previous years. The importance of maintaining the present conditions requires that sufficient funds should be reserved to check immediately any tendency toward enlargement and keep Old River and the Atchafalaya at all times under safe control. The effect of the recent contraction caused by the construction of railway embankments has not yet been fully ascertained, but some scour in Old River at the railway bridge has occurred.

New Orleans Harbor, 965 miles below Cairo, right and left bank.—The object of the work in this harbor is to prevent the erosion of banks and consequent loss and damage to adjacent property. The work consists mainly of spur dikes, placed at intervals of about 450 feet, and of continuous revetment of the lower bank. In places where erosion was specially active continuous revetment was placed between the spurs. The banks are protected in Carrollton Bend at the upper end of the harbor in the vicinity of Southport; in Greenville Bend, opposite Audubon Park; Gouldsboro Bend to Algiers Point, and in the third district reach. A total of about 5½ miles of bank is thus protected by dikes and continuous revetment. During the past season the revetment of Southport was extended by 4,750 linear feet. The steep banks and great depths of water make the preservation of the banks in New Orleans Harbor both difficult and expensive, and the danger of sudden collapse in certain localities is by no means remote. Under the conditions here found it is of more than ordinary importance that ample means should be provided for the extension and completion of the revetment necessary to make the river banks along the city front reasonably safe.

For further details concerning the work in this district see the reports of Capt. Charles S. Bromwell, Corps of Engineers, U. S. Army, and Assistant Engineer H. S. Douglas, appended hereto.

PLANT IN THE SEVERAL DISTRICTS.

First and second districts.—This plant is located a short distance below Memphis when not in active service. During the spring and summer of 1903 repair work upon it was actively carried on, and its previous very bad condition much improved. The towboats *Chisca* and *Titan* received extensive repairs, and barges and quarter-boats were much improved. This work was continued after the working season, and by the beginning of the next working season nearly the complete outfit will be in effective condition. No new plant has been purchased or built for the first and second districts since 1894, except one flat 60 by 16 feet built during the past year, and the propeller steamer *Unique*, recently purchased from the Ward's Engineering Works of Charleston, W. Va. This steamer is of a type radically different from any in use on the Mississippi River, and was purchased partly as an experiment. It has a steel hull 90 feet long, 14 feet beam, 4½ feet depth, 28 inches draft, 18¾ feet width over guards. The boiler is tubular, with outboard condensers. The engine is triple expansion, of a very compact type, developing about 200 horsepower, with a coal consumption of about 2 pounds per indicated horsepower. The propeller is 46 inches in diameter and operates in a recess built into the hull, which completely protects it from drift. It is expected to utilize this boat for surveying and inspection purposes, and also to conduct with it a series of experiments to determine the value of this type for towboats and other vessels in use on Commission work.

Third district.—The plant pertaining to the third district is cared for at Greenville, [illegible], when not in use. General repair work has been continued up[illegible] it, and it has been maintained in good condition. Twelve new [illegible] ucted and a new steel hull towboat is neari[illegible] the provision for rebuilding the hulls of the tug *Parker* and the hydraulic grader this plant will be in excellent condition by the working season. Half of the cost of the steamer *Unique*, above mentioned, was paid from the allotment to the third district plant.

For further details respecting plants in the first, second, and third districts reference is made to the reports of Capt. E. W. Van C. Lucas, hereto appended.

Fourth district.—The plant pertaining to the fourth district is cared for at New Orleans, La. General repairs to the entire plant have been made, and it is now, with few exceptions, in good condition. Contracts for the construction of 14 standard gunwale barges have been made and 6 of them delivered. Contract for the construction of a small steel hull steamboat has been made and the boat is well advanced toward completion.

For further details of the plant in the fourth district reference is made to the report of Capt. Charles S. Bromwell, hereto appended.

Other plant.—An equipment of towboats, pile sinkers, and barges is maintained for use in connection with the operation of the dredge boats. A tract of land at West Memphis, Ark., containing about 9 acres, has been purchased for storage and other uses, and a warehouse and machine shop have been erected, with an outfit of the simpler machines and tools needed in the work of repairs.

For details respecting this plant and repairs upon it reference is made to the reports of the Secretary and Assistant Engineer F. B. Maltby, hereto appended.

LEVEES.

The levees of the first and second engineer districts, comprising the following levee districts: Upper St. Francis, Missouri; Reelfoot, Kentucky and Tennessee; Lower St. Francis, Missouri and Arkansas; Upper Yazoo, Mississippi, and White River, Arkansas, are in charge of Capt. E. W. Van C. Lucas.

The Upper St. Francis levee district extends on the right bank from Birds Point, Mo., opposite Cairo, to the mouth of Bayou St. John, just above New Madrid, with a river frontage of 70 miles and an area of 700 square miles. The levee projected by the Commission will be 54 miles long, of which 6 miles have been built.

At the end of the fiscal year the United States had placed 377,198 cubic yards and the levee board and private parties 283,804 cubic yards, a total of 661,002 cubic yards. During the fiscal year ending June 30, 1905, the United States will expend $15,000 and the local board and private parties about the same amount.

The complete protection of this district depends upon a levee from Birds Point to the high land in the vicinity of Cape Girardeau, which is above the mouth of the Ohio River. This line is incomplete and in bad repair. As it is justly and logically to be regarded as part of St. Francis Basin levee system, the Commission recommends that all doubt as to the right to include it in allotments for levees in that basin be removed by express authority in the law.

The Reelfoot levee district extends on the left bank from Hickman, Ky., to Slough Landing, Tenn., with a river frontage of 24 miles and an area of 318 square miles. The projected levee line has a length of 21 miles, of which 4½ miles in Tennessee have been built by the local authorities, and about 5¼ miles in Kentucky by the United States and the local board. To date the total yardage placed is 789,131—253,361 by the United States and 535,770 by the local boards. During the coming year the United States will do about $15,000 worth of work and the local boards are expecting to spend from $5,000 to $10,000.

Yardage to complete the levee, 1,300,000.

The Lower St. Francis levee district extends on the right bank from Point Pleasant, Mo., to the mouth of the St. Francis River, with a river frontage of 219 miles and an area of 3,500 square miles. The projected levee has a length of about 213 miles, two sections of which, respectively 178 miles and about 15 miles in length, have been built, with an intervening gap about 13 miles in length, which is now being closed by the St. Francis levee board of Arkansas.

Yardage erected during the year, 683,057 by the United States and 657,817 by the levee board, a total of 1,340,874 cubic yards. The levee at present contains 15,249,972 cubic yards, of which the United States placed 5,234,111 cubic yards, and the local authorities 10,071,861 cubic yards. To complete the levee system of this district will require the addition of 8,800,000 cubic yards. Contracts have been made for placing 700,000 cubic yards during the coming year with Government funds, and the levee board expects to place about 1,600,000 cubic yards additional.

The Upper Yazoo levee district extends on the left bank, with a river frontage of 121 miles, from the hills south of Horn Lake, Tennessee, below Memphis, to the lower Coahoma County line. This levee has a length of 124 miles, and protects an area of 3,281 square miles. During the present year the United States built 373,853 cubic yards of new work and the levee board 1,333,891 cubic yards additional, a total of 1,707,744 cubic yards. This levee now contains 22,090,622 cubic yards, of which 6,617,786 cubic yards were placed by the United States and 15,962,836 cubic yards by the levee board. It needs for completion 5,100,000 cubic yards. During the coming year an expenditure of $70,000 is proposed by the Commission.

The White River levee district extends from Helena, Ark., 74 miles down the right bank, and has an area of 910 square miles. The line is complete in length, with the exception of four breaks out of the fourteen caused by the flood of 1897, which have been kept open until the grade and section of the rest of the line shall have been sufficiently improved. Their aggregate length is 10,000 feet. The levee is 74 miles long, of which 67 miles is under Government control, and the remaining 7 miles under the control of the Laconia levee board.

During the present fiscal year the United States constructed 449,770 cubic yards of new work, and the levee boards 142,980 cubic yards additional, a total of 592,750 cubic yards. The levee now contains 8,311,715 cubic yards, of which 6,678,495 cubic yards were built by the United States, and 1,633,220 by the levee board. There is needed to complete this line about 8,100,000 cubic yards of additional work.

More complete details concerning the conditions and needs of the levees in the first and second engineer districts can be obtained from the reports of Capt. E. W. Van C. Lucas and of his assistant engineers, A. J. Nolty, Charles Le Vasseur, M. Gardner, and A. F. Kilpatrick, hereto appended.

The levees of the third engineer district, comprising the Lower Yazoo, Mississippi, and Upper Tensas, Arkansas and Louisiana levee districts, were in charge of Capt. Charles L. Potter from July 1 to 7, 1903, and Capt. E. W. Van C. Lucas since July 7, 1903.

The Lower Yazoo levee district extends on the left bank from the upper line of Bolivar County, Miss., to the mouth of the Yazoo River above Vicksburg, with a river frontage of 227 miles and area of 3,367 square miles. The length of the levee line is 187 miles. During the year the United States has constructed 1,905,843 cubic yards of new and enlargement work and the levee board 1,738,266 cubic yards additional, a total of 3,644,108 cubic yards. The levee now contains 35,615,386 cubic yards, of which 16,020,000 cubic yards were built by the United States and 19,595,386 by the levee board. There is needed to complete this levee about 13,000,000 cubic yards of additional work. During the coming season the Commission proposes to expend $100,000 and the levee board in the neighborhood of $1,000,000 additional, the greater part of which will be needed for new loops made necessary by caving banks.

The Upper Tensas levee district extends on the right bank from the highlands on the south side of the Arkansas River to a point in Louisiana opposite Warrenton, with a river frontage of 204 miles and an area of 2,875 square miles. The length of levee line is 186.8 miles. During the past year there has been added to the levee by the United States 677,090 cubic yards, and by the levee boards 1,808,210 cubic yards additional, a total of 2,485,300 cubic yards. The levee now contains 30,784,126 cubic yards, of which 18,470,476 cubic yards were built by the United States and 12,313,650 by the levee boards, and needs for completion 19,000,000 cubic yards additional, which includes an extension of the Arkansas River levee of about 6 miles, necessary to complete the system. During the coming year the Commission proposes to expend in this district $230,000, to which the Louisiana levee boards will make considerable additions and the Arkansas levee boards small additions.

For more detailed information concerning the condition and requirements of the levees in this district reference is made to the reports of Capt. E. W. Van C. Lucas and of his assistant engineers, Arthur Hider, A. Miller Todd, and E. C. Tollinger, hereto appended.

The levees of the fourth engineer district, comprising the Lower Tensas, Atchafalaya, Lafourche, Barataria, Pontchartrain, and Lake Borgne levee districts, all in Louisiana, were in charge of Capt. Chas. S. Bromwell, Corps of Engineers, U. S. Army, until May 27, 1904, and since that date temporarily in charge of Lieut. Col. H. M. Adams, Corps of Engineers, U. S. Army.

The Lower Tensas levee district extends on the right bank, in continuation of the Upper Tensas district, from a point opposite Warrenton, Miss., to the mouth of Red River, with a river frontage of 158 miles and an area of 2,080 square miles.

The levee line is continuous from the upper end of the district down to Bougere Landing. At a distance of 6.72 miles below the lower end of the continuous levee there is a stretch of 8.78 miles of levee. The length of constructed levee is 143.47 miles, but 17 miles of levee are projected to connect the levees and extend them down to the lower end of the district.

At the end of the last fiscal year the levee line of this district contained 17,947,083 cubic yards. The net increase in cubic yardage since then is 915,943.

The Atchafalaya levee district extends on the right bank from the Red River to Bayou Lafourche, with a river frontage about 122 miles long. The length of the levee line is 127.75 miles, and the area protected is 6,085 square miles. At the end of the last fiscal year the contents were 19,411,930 cubic yards, and the net increase since that time is 753,106 cubic yards.

The Lafourche and Barataria levee districts extend on right bank from Bayou Lafourche to Head of the Passes, omitting the city of New Orleans. The river front is 160.5 miles. The levee line terminates at the Jump, with a length of 149.5 miles. The area protected is 2,020 square miles. The cubic yards of earthwork in the levees on June 30, 1903, were 11,005,740, and the net increase for the present fiscal year is 490,990 cubic yards.

The Pontchartrain and Lake Borgne levee districts extend on the left bank from Baton Rouge, La., to Head of the Passes, exclusive of the city of New Orleans, a distance of 214.5 miles. The levee line is 202.67 miles in length and terminates at Salt Works, 5 miles below Fort St. Philip. The levees protect an area of 1,816 square miles, and they contained at the end of the last fiscal year 17,981,408 cubic yards. The net increase for the current fiscal year is 1,084,771 cubic yards.

For more complete details concerning the levees in the fourth district reference is made to the reports of Capt. Chas. S. Bromwell, Corps of Engineers, U. S. Army, and of Supt. W. E. Knobloch, here appended.

HIGH-WATER STAGES.

The high-water season was marked by long continued, moderately high stages. No crevasses occurred. The highest gauge readings at the points named below were as follows. The highest readings at the same places during 1903 are also given for comparison:

	1904.	1903.		1904.	1903.
Cairo	49.10	50.57	Lake Providence	42.45	46.48
Fulton	37.40	40.15	Vicksburg	46.81	51.80
Memphis	39.20	40.10	Natchez	45.50	50.35
Helena	47.62	51.00	Red River	43.70	50.08
Arkansas City	48.96	52.90	Carrollton	16.32	19.42
Greenville	43.55	49.10			

The levels reached were far above the natural banks in all parts of the river. But for the levees there would have been widely extended overflow.

MAP OF THE ALLUVIAL VALLEY.

With a view, mainly, of exhibiting the present extension of the levee system and the development of the adjacent country which has followed it, the Commission has caused to be prepared a map of the alluvial valley, which is hereto appended, p. 26. This map is limited to the area which would be subject to overflow if unprotected. The heavy black lines following the course of the river represent the levees now existing, about 1,418 miles in length. It shows also the railroads in lighter black lines with their names indicated by initials; and the location of bars on which dredging has been done, with the dates of working on them, and the lo[illegible]ion of United States gauges; also the United States levee district[illegible]u, in Louisiana, the State levee districts as well.

No fact connected with the recent history of the alluvial valley, apart from its levee system, is of higher significance than the building of its railroads. With the exception of two or three transcontinental lines which were compelled to cross the valley at whatever cost of construction and hazard of interruption, they have all been built within few years past, and since the participation of the United States in the work of levee building has inspired confidence in the permanence and certainty of protection from overflow. Except for this confidence the railroads would not have been built. Without the continued maintenance of the levees they can not be kept up and operated.

The alluvial country contains vast supplies of timber which can not be gotten to market without railroads. Unlike some timbered countries, the lands of the alluvial valley will have a value and productiveness, after the removal of the timber, to insure permanent prosperity, both to the railroads and the inhabitants. It would be a reasonable assumption that a region possessing such natural resources and holding out such promise of commercial growth and prosperity as to induce the building of railroads to the extent shown on the map of the alluvial valley referred to would respond to the opportunities offered by the railroads in rapid development of business activity. That assumption has been signally verified in the present case. The network of railroads shown on the map is an index of the phenomenal growth and prosperity which has attended and followed their building.

As an illustration of the rapid growth of population, business, and wealth which has taken place in the alluvial valley since confidence has been established in protection against overflow, the following facts and figures are submitted relating to the Yazoo Basin, obtained from unofficial but trustworthy sources.

Between 1881 and 1884 a line of railroad was constructed down the axis of the Yazoo Basin from Memphis to Vicksburg, 225 miles in length. Nearly or quite three-fourths of the country was unimproved and covered with heavy forests. About 1890, the railroad having passed into the control of the Illinois Central Railroad Company, the construction of branch lines began, and has continued since, and is going on now. The total mileage in the basin has increased from 225 miles in 1890 to 816 in 1903, and is still extending. The lumber industry, which was the first to feel actively the effect of this railroad building, has grown to enormous proportions. The lumber is shipped out as logs, boards, heading, staves, box stuff, spokes, and every other form of merchantable lumber. Great areas of land in the interior of the basin, which were formerly regarded as irreclaimable swamps, have been cleared, drained, and put under cultivation, and have been found to have greater fertility and productive capacity than the older and higher land. Flourishing crops are to be seen to-day growing in depressions where the high-water marks of former floods are 20 to 25 feet up on the trees.

The population of the basin increased from 94,672 in 1880 to 195,346 in 1900, and has continued to increase at as rapid a rate since. The assessed value of taxable property in 1902 was $42,000,000, exclusive of railroad property, which was an increase of more than 60 per cent. The increase in the market value of real estate has been far greater—probably twice that amount. Ten years ago the basin had 2 banks, with aggregate capital of $350,000; now there are 51 banks, with aggregate capital of over $3,000,000. There are 28 oil mills and 8 cotton compresses, representing an investment in the aggregate of nearly $8,000,000. The number of sawmills and mills for the manufacture of lumber in various forms is not known, but is very large.

Effective and successful levee building began in 1884, when the Upper Yazoo levee district was organized under the laws of the State. The Lower Yazoo levee district was organized prior to that time, but had not done effective work, and could not without the active cooperation of the citizens of the upper district. The basin is a single area in its relation to the river, and must be so treated for the purpose of protection. The first act of the levee board of the upper district was to issue $500,000 of bonds at 8 per cent, from which $487,500 was raised by the aid of the railroad company. Afterwards a further issue of $400,000 was authorized and again negotiated by the aid of the railroad company. The 4 per cent bonds of the same district now command a premium of 20 per cent.

Almost contemporaneously with these proceedings the United States, under the provisions of the law creating the Mississippi River Commission and subsequent laws, began to expend money to aid in the building and repair of levees. This cooperation greatly stimulated the efforts of the citizens of the basin, and the levee board used its power to levy taxes for levee building to the limit of the ability of the people to pay. The levee taxes in the Upper Yazoo levee district for 1886 amounted, in round numbers, to $118,000; in 1903 to $431,755. The aggregate cotton production in the two Yazoo levee districts, the upper and the lower, in 1879 was estimated at 185,868 bales; in 1903 at 426,414 bales. This increase of the production of cotton is emphasized by the fact that in recent years there has been a greater relative increase in the product of other crops than in cotton. Planters have been striving to improve their agriculture and secure a higher degree of industrial independence by introducing greater variation of crops, and the culture of corn, peas, clover, and alfalfa has been greatly increased.

This growth of population, production, and business has affected every interest of society. The Yazoo Basin is sprinkled with towns whose sites were the home of the bear and the wild cat ten years ago. Churches and schools have multiplied, and the people are better housed, better clothed, and better fed than formerly. These changes touch one sociological and industrial problem of interest and importance. The Yazoo Basin is an ideal home and the raising of cotton an ideal occupation for the negro. The simplicity of its culture, its ready sale, and the fact that it can be grown with profit on a small scale adapt it perfectly to the capacity and taste of the negro, whether as an employee or a small tenant. The increasing extent of its cultivation in recent years has attracted a great emigration of that race from the highlands to the Yazoo country, and given them the advantage of active competition for their services.

What has been said of the Yazoo Basin is true, in the main, of the whole alluvial valley. The facts in regard to that part of it have been stated as illustrating the rapid advance which has taken place in all the country subject to overflow, in every element of prosperity, as a result of protection against floods. So far as we know it is, in all its circumstances, without a parallel in the history of public works.

It need hardly be said that the preservation of these beneficial conditions depends upon the continuance of the confidence which has been created in the minds of men in the security and permanence of protection from overflow. It was the intervention of the strong arm of the

Federal Government that created that confidence, and it alone can maintain it. To do this will require a continuance of expenditures for a number of years to come, and to do it well and certainly they should be at an increased rate for a few years.

The maintenance of a completed levee system would be a burden entirely within the resources of the riparian States and communities if it were not for the caving of its banks by the river. This occurs in the bends, and as they are elongated by the caving the river works its way to the levees at those points and undermines them. This action takes place only at intervals both of time and locality. The river goes through periodical intervals of change or tendency to change, in various localities, followed by intervals of comparative stability. In the Lower Yazoo levee district and in the Lower Tensas district changes are taking place in bank lines which threaten injury to important levees in the near future. Such cases have to be met in one of two ways; either by checking the caving of the bank by revetment, or by building a new levee on ground farther from the river. The expense of the former is such that it can be resorted to only in cases where the levee threatened is so situated that a new location can not be found except at a great distance from the river, or where extremely valuable interests would be sacrificed by the change of line, or where there is a lake or impassable swamp lying immediately behind the existing levee, or a town or city which would be thrown open to overflow by the change of line. That method of protection has been applied in four places on the river in the past; one at Lake Bolivar, in the Upper Yazoo levee district, where the revetment has been in place fifteen years, and gives every promise of permanent success; one at Lake Providence, in the Lower Tensas levee district, where the revetment was begun in 1894 and substantially completed in 1900; one at Bondurant, in the Lower Tensas district, where the revetment has been in place for four years, and one at Kempe Bend, also in the Lower Tensas district, where the revetment was begun in 1899 and has been in course of extension and strengthening since. At Kempe Bend the situation is critical; at Lake Providence and Bondurant the work has been entirely successful so far, and gives reasonable promise of permanence. One other situation of a similar sort exists at Longwood, in the Lower Yazoo district, where a revetment will be built during the coming season. Some other critical points will have to be provided for in the near future, either by revetment or by relocation of the line, as may be determined later.

It was in view of this situation that the Commission, in its last annual report, recommended that authority be given to make contracts for levees to be paid out of the appropriation for the year ending June 30, 1906, when available, which was subsequently authorized by the act of April 28, 1904. It is believed that the authority thus given was much to the interest of the work. For the same reason the Commission strongly urges the necessity of larger appropriations for levee work for a few years to come than have been available for several years past. The interests involved are so vast, and so much depends upon the uninterrupted maintenance of the system now so well advanced toward completion, that it would be a failure of duty on the part of the Commission to omit to state this recommendation with earnestness and emphasis.

It is proper to have in mind in this connection that as the riparian communities reap greater and greater advantages from the protection afforded by the levees they ought to contribute more and more to the

Money statements.

Appropriations expended under Mississippi River Commission.

[Appropriation for improving Mississippi River.]

July 1, 1903, balance unexpended		[a]$2,966,681.53
Amount appropriated by sundry civil act approved April 28, 1904	$2,000,000.00	
Miscellaneous receipts from sales of engineer property under the provisions of section 5 of river and harbor act of June 13, 1902, and other sources	7,402.69	
		2,007,402.69
		4,974,084.22
June 30, 1904, amount expended during fiscal year		2,258,016.04
July 1, 1904, balance unexpended		2,716,068.18
July 1, 1904, outstanding liabilities	53,220.00	
July 1, 1904, amount covered by uncompleted contracts	364,957.49	
		418,177.49
July 1, 1904, balance available		2,297,890.69
Distributed as follows:		
Mississippi River Commission		955.51
Surveys, gauges, and observation		11,575.82
Levees		168,050.40
Revetment and contraction works, permanent channel improvements and protection		3,584.53
Dredges and dredging		88,445.43
Plant and miscellaneous		7,338.97
Improving harbors and tributaries		15,061.73
Unallotted		2,002,878.30
		2,297,890.69

Amounts necessary to be appropriated for the fiscal year ending June 30, 1906, in addition to the balance unexpended July 1, 1904.

For continuing the improvement of the Mississippi River from Head of the Passes to the mouth of the Ohio River, including salaries and clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission	$3,000,000.00
Improving harbor at Memphis Tenn. (including Wolf River)	25,000.00
Improving harbor at Natchez, Miss., and Vidalia, La	200,000.00
Rectification of Red and Atchafalaya rivers, Louisiana	50,000.00
Improving harbor at New Orleans, La	300,000.00
	3,575,000.00

[Appropriation for gauging the waters of the Lower Mississippi and its tributaries.[b]]

July 1, 1903, balance unexpended		1,541.36
Amount allotted by Chief of Engineers, April 18, 1903, from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, as amended by section 9 of river and harbor act of June 13, 1902		9,100.00
		10,641.36
June 30, 1904, amount expended during fiscal year	$6,987.94	
June 30, 1904, amount reverted to Treasury during fiscal year	887.34	
		7,875.28

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[a] Amount, $2,966,670.03, shown in report for 1903, increased $11.50 reclamation on check No. 143777 on Assistant Treasurer, St. Louis, Mo., on account of forged indorsement, deposited to credit of Treasurer of the United States in June, 1901.

[b] The custody and care of the gauges maintained under this appropriation were assumed by the issippi River Commission February 11, 1901, on which date they were transferred to the secretary, er authority of Secretary of War, dated January 25, 1901.

July 1, 1904, balance unexpended	$2,766.08
July 1, 1904, outstanding liabilities	2,300.75
July 1, 1904, balance reverting to Treasury	465.33
Amount that can be profitably expended in fiscal year ending June 30, 1906, in addition to the balance unexpended July 1, 1904	9,100.00

[Appropriation for waterway from Lockport, Ill., to St. Louis, Mo.]

July 1, 1903, balance unexpended	17,527.52
June 30, 1904, amount expended during fiscal year	8,373.97
July 1, 1904, balance unexpended	9,153.55
July 1, 1904, outstanding liabilities	1,675.24
July 1, 1904, balance available	7,478.31

Consolidated statement of all appropriations expended under the Mississippi River Commission to June 30, 1904.

[Appropriation for improving Mississippi River.]

Act of June 28, 1879 (organic)	$175,000.00
Act of June 16, 1880 (sundry civil)	150,000.00
Act of March 3, 1881 (river and harbor)	1,000,000.00
Act of March 3, 1881 (sundry civil)	150,000.00
Act of August 2, 1882 (river and harbor)	4,123,000.00
Act of August 7, 1882 (sundry civil)	150,000.00
Act of March 3, 1883 (sundry civil)	150,000.00
Act of January 19, 1884 (river and harbor)	1,000,000.00
Act of July 5, 1884 (river and harbor)	75,000.00
Act of July 5, 1884 (river and harbor), less $5,000 transferred to snagboat service	2,065,000.00
Act of July 7, 1884 (sundry civil)	75,000.00
Act of August 5, 1886 (river and harbor), less $5,942.60 for expenses, office Chief of Engineers	1,994,057.40
Act of August 5, 1886 (river and harbor), less $47.30 for expenses, office Chief of Engineers	29,952.70
Act of August 11, 1888 (river and harbor), less $4,859 for expenses, office Chief of Engineers	2,840,141.00
Act of August 11, 1888 (river and harbor)	75,000.00
Act of October 2, 1888 (sundry civil)	35,000.00
Act of October 19, 1888 (deficiency), less $4,214.39 reverted to the Treasury	20,785.61
Act of September 19, 1890 (river and harbor)	3,200,000.00
Act of September 30, 1890 (deficiency)	5,625.00
Act of March 3, 1891 (deficiency)	1,950.00
Act of March 3, 1891 (joint resolution)	1,000,000.00
Act of July 13, 1892 (river and harbor)	2,470,000.00
Act of July 28, 1892 (deficiency)	44.80
Act of March 3, 1893 (sundry civil)	2,665,000.00
Act of August 18, 1894 (river and harbor)	485,000.00
Act of August 18, 1894 (sundry civil)	2,665,000.00
Act of March 2, 1895 (sundry civil)	2,665,000.00
Act of June 3, 1896 (river and harbor)	909,000.00
Joint resolution approved March 31, 1897 (Public, No. 6)	250,000.00
Act of June 4, 1897 (sundry civil)	2,933,333.00
Act of July 19, 1897 (deficiency)	625,000.00
Act of July 1, 1898 (sundry civil)	1,983,333.00
Act of March 3, 1899 (sundry civil)	2,583,333.00
Act of March 3, 1899 (river and harbor)	185,000.00
Act of June 6, 1900 (sundry civil), less $5,000 for expenses, office Chief of Engineers	2,245,000.00
Act of June 13, 1902 (river and harbor)	90 00

Act of June 13, 1902 (river and harbor)		$2,200,000.00
Act of March 3, 1903 (sundry civil)		2,000,000.00
Act of April 28, 1904 (sundry civil)		2,000,000.00
Total specific appropriations		47,269,555.51
Balances from former appropriations applied to works below Cairo under act of August 2, 1882, less $123.42 reverted to Treasury	$272,504.96	
Same for works above Cairo, under act of July 5, 1884	22,632.53	
Total balances		295,137.49

MISCELLANEOUS RECEIPTS.

Amount received from Quartermaster's Department, U. S. Army, September 21, 1898, on account reimbursement for plant loaned during war of 1898 and lost at sea (taken up by fourth district officer in January, 1899)	$8,000.00	
Amount received in December, 1903, in settlement of claim against Southern Pacific tug *El Valle* for damages to dredge *Beta*, collected by U. S. attorney for eastern district of Louisiana. Credited to "Dredges and Dredging," secretary's office	159.00	
Amount received in December, 1903, in settlement of claim against steamer *H. M. Carter* for damages to barge No. 33, collected by the Solicitor of the Treasury. Credited to "Plant," fourth district office	18.00	
Amounts received from sales, etc., under the provisions of section 5 of river and harbor act of June 13, 1902:		
By secretary—		
From sales in September, 1903, credited to unallotted balance	3.50	
From sales in February, 1904, credited to unallotted balance	25.00	
By first and second district officer—		
From sales in October, 1903, credited to unallotted balance	79.10	
From sales in April, 1904, reallotted to "Plant"	260.00	
By third district officer—		
From sales in December, 1902 (not previously taken up), credited to unallotted balance	156.35	
From sales in March, 1904, reallotted to "Plant"	1,350.00	
By fourth district officer—		
From sales in July, August, and September, 1903, reallotted to "Plant"	3,938.64	
From sales in October, 1903, reallotted to "Plant"	1,318.00	
From sales in April, 1904, reallotted to "Plant"	82.50	
From sales in May, 1904, reallotted to "Plant"	12.60	
Previously reported	905.16	
Total miscellaneous receipts		16,307.85
Total		47,581,000.85

EXPENDED.

Location and object.	To June 30, 1903.	During year ending June 30, 1904.	Total.
Mississippi River Commission	$674,222.28	$38,989.49	$713,211.77
Surveys, gauges, and observations	2,014,764.60	72,167.99	2,086,932.59
Levees	17,274,634.52	1,103,338.05	18,377,972.57
Revetment and contraction works, permanent channel improvements and protection	10,411,500.76	249,632.85	10,661,133.61
Dredges and dredging	[a]3,016,040.76	281,608.90	3,297,649.66
Experimental dikes	98,885.50	1,114.50	100,000.00
Plant and miscellaneous	1,925,826.00	296,638.95	2,222,464.95
Improving harbors and tributaries	6,453,409.68	214,525.31	6,667,934.99
Works above Cairo	737,632.53	....	737,632.53
Total expended	42,606,916.63	2,258,016.04	44,864,932.67
Balance unexpended June 30, 1904	....	....	713,189.88
Unallotted	....	....	2,002,878.30
Total appropriated, etc	....	....	47,581,000.85

[a] Amount, $3,016,052.26, shown in Annual Report for 1903, reduced $11.50 reclamation on check No. 143777 on assistant treasurer, St. Louis, Mo., on account of forged indorsement, deposited to credit of Treasurer of United States in June, 1901.

[Appropriation for gauging the waters of the lower Mississippi and its tributaries.]

Allotments from general appropriations for examinations, surveys, and contingencies of rivers and harbors by acts of—	
March 3, 1871	$5,000.00
June 10, 1872	5,000.00
March 3, 1873	5,000.00
June 23, 1874	5,000.00
March 3, 1875	5,000.00
Specific appropriations by river and harbor acts of—	
August 14, 1876	5,000.00
June 18, 1878	5,000.00
March 3, 1879	5,000.00
June 14, 1880	5,000.00
March 3, 1881	5,000.00
August 2, 1882	5,000.00
Deficiency act of March 12, 1884	2,100.00
Specific appropriations by river and harbor acts of—	
July 5, 1884	5,000.00
August 5, 1886	5,000.00
Allotted from specific appropriation by river and harbor act of August 11, 1888	8,700.00
Deficiency act of October 19, 1888	3,600.00
Allotments from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, for fiscal years, viz:	
1890	9,000.00
1891 (less $3,518.34 withheld in United States Treasury under ruling that only $6,000 can be expended each fiscal year)	5,181.66
1892	5,100.00
1893	5,500.00
1894	5,500.00
1895	5,500.00
1896	5,500.00
1897	5,500.00
1898	5,500.00
1899	6,000.00
1900	5,500.00
1901	6,000.00
1902	6,000.00
Allotments from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, as amended by section 9 of river and harbor act of June 13, 1902, for fiscal years, viz:	
1903	9,100.00
1904	9,100.00
Total	173,381.66

EXPENDED.

	To June 30, 1903.	During year ending June 30, 1904.	Total.
Expenditures	$155,268.43	$6,987.94	$162,256.37
Unexpended balances reverted to Treasury	8,359.21		8,359.21
Total	163,627.64	[a] 6,987.94	170,615.58
Unexpended balance June 30, 1904			2,766.08
Total appropriated, etc			173,381.66

[a] Includes $1.57 on Treasury settlement from funds previously allotted and reverted to the Treasury.

[Appropriation for waterway from Lockport, Ill., to St. Louis, Mo.]

Act of June 13, 1902 (river and harbor) $25,000.00

EXPENDED.

	To June 30, 1903.	During year ending June 30, 1904.	Total.
Expenditures	$7,472.48	$8,373.97	$15,846.45
Unexpended balance June 30, 1904			9,153.55
Total appropriated, etc			25,000.00

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1904.

SECRETARY MISSISSIPPI RIVER COMMISSION.

[Appropriations: Improving Mississippi River; gauging the waters of the lower Mississippi and its tributaries; waterway from Lockport, Ill., to St. Louis, Mo.]

	Appropriation for improving Mississippi River, allotment for—				
	Mississippi River Commission.	Surveys, gauges, and observations.	Dredges and dredging.	Expended allotments.	Total.
Amount expended on previous projects	$238,110.74	$855,247.37			$1,093,358.11
Amount expended on present project to end of last fiscal year	436,111.54	866,998.01	[a] $2,625,436.65	[b] $46,131.14	[a] 3,974,677.34
Balance unexpended at end of last fiscal year	14,377.46	13,937.32	[c] 221,507.65		[c] 249,822.43
Amount appropriated or allotted since (net)	27,000.00	65,000.00	236,159.00		328,159.00
	41,377.46	78,937.32	457,666.65		577,981.43
Amount expended from beginning of present fiscal year to end of previous month	37,303.97	50,573.07	263,227.34		351,104.38
Amount expended during the month	1,685.52	5,721.19	[d] 18,381.56		25,788.27
	38,989.49	56,294.26	281,608.90		376,892.65

[a] Amount reported June 30, 1903, reduced $11.50 reclamation on check No. 143777 on assistant treasurer, St. Louis, Mo., on account of forged indorsement, deposited to credit of Treasurer of United States in June, 1901.

[b] Experimental dikes, $45,075.58; patrol of the Mississippi River, $1,055.56.

[c] Amount reported June 30, 1903, increased $11.50 reclamation on check No. 143777 on assistant treasurer, St. Louis, Mo., on account of forged indorsement, deposited to credit of Treasurer of United States in June, 1901.

[d] Includes 79 cents in Treasury settlement No. 26780, June 13, 1904, with the Pittsburg, Cincinnati Chicago and St. Louis Railway Company for freight transportation. (101/1, sec. M. R. C.)

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1904—Continued.

SECRETARY MISSISSIPPI RIVER COMMISSION—Continued.

	Appropriation for improving Mississippi River, allotment for—				
	Mississippi River Commission.	Surveys, gauges, and observations.	Dredges and dredging.	Expended allotments.	Total.
Balance unexpended at end of month.	$2,387.97	$22,643.06	$176,057.75	....	$201,088.78
In Treasury United States	513.56	19,945.89	163,891.22	....	184,350.67
In hand	1,874.41	2,697.17	12,166.53	....	16,738.11
	2,387.97	22,643.06	176.057.75	....	201,088.78
Outstanding liabilities at end of month	1,432.46	5,122.19	25,362.32	....	31,916.97
Amount covered by existing contracts at end of month	....	7,026.08	62,250.00	....	69,276.08
	1,432.46	12,148.27	87,612.32	....	101,193.05
Balance available at end of month	955.51	10,494.79	88,445.43	....	99,895.73

	Appropriation for gauging the waters of the lower Mississippi and its tributaries.	Appropriation for waterway from Lockport, Ill., to St. Louis, Mo.	Grand total.
Amount expended on previous projects	....	....	$1,093,358.11
Amount expended on present project to end of last fiscal year	$155,268.43	$7,472.48	[a] 4,137,418.25
Balance unexpended at end of last fiscal year	652.45	17,527.52	[b] 268,002.40
Amount appropriated or allotted since (net)	9,100.00	....	337,259.00
	9,752.45	17,527.52	605,261.40
Amount expended from beginning of present fiscal year to end of previous month	6,704.41	8,283.73	366,092.52
Amount expended during the month	281.96	90.24	26,160.47
	6,986.37	8,373.97	392,252.99
Balance unexpended at end of month	2,766.08	9,153.55	213,008.41
In Treasury United States	....	8,000.00	192,350.67
In hand	2,766.08	1,153.55	20,657.74
	2,766.08	9,153.55	213,008.41
Outstanding liabilities at end of month	2,300.75	1,675.24	35,892.96
Amount covered by existing contracts at end of month	....	....	69,276.08
	2,300.75	1,675.24	105,169.04
Balance available at end of month	[c] 465.33	7,478.31	107,839.37

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[a] Amount reported June 30, 1903, reduced $11.50 reclamation on check No. 143777 on assistant treasurer, St. Louis, Mo., on account of forged indorsement, deposited to credit of Treasurer of United States in June, 1901.

[b] Amount reported June 30, 1903, increased $11.50 reclamation on check No. 143777 on assistant treasurer, St. Louis, Mo., on account of forged indorsement, deposited to credit of Treasurer of United States in June, 1901.

[c] Balance of $465.33 reverts to Treasury.

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1904—Continued.

WORKS ABOVE CAIRO.

[Appropriation: Improving Mississippi River.]

	Protection near Cairo.[a]	Des Moines Rapids to Ohio River.	Total.
Amount expended on previous protects	....	....	....
Amount expended on present project to end of last fiscal year	$50,000.00	$687,632.53	$737,632.53
Balance unexpended at end of last fiscal year	....	....	....
Amount appropriated or allotted since (net)	....	....	....
	....	....	....
Amount expended from beginning of present fiscal year to end of previous month	....	....	....
Amount expended during the month	....	....	....
	....	....	....
Balance unexpended at end of month	....	....	....
In Treasury United States	....	....	....
In hand	....	....	....
	....	....	....
Outstanding liabilities at end of month	....	....	....
Amount covered by existing contracts at end of month	....	....	....
	....	....	....
Balance available at end of month	....	....	....

[a] Includes only work under act of July 5, 1884.

FIRST AND SECOND DISTRICTS.

[Appropriations: Improving Mississippi River; repairing Government levee at Walnut Bend, Ark.]

	Improving Mississippi River, allotment for—				
	Surveys.	Upper St. Francis levee district.	Lower St. Francis levee district.	White River levee district.	Reelfoot levee district.
Amount expended on present project to end of last fiscal year	$109,126.59	$40,000.00	$773,274.48	$1,247,896.65	$18,141.29
Balance unexpended at end of last fiscal year	46.52	....	53,652.52	37,837.95	1,858.71
Amount appropriated or allotted since (net)	5,000.00	20,000.00	125,000.00	90,000.00	20,000.00
	5,046.52	20,000.00	178,652.52	127,837.95	21,858.71
Amount expended from beginning of present fiscal year to end of previous month	4,793.98	19,008.51	118,801.57	110,491.08	20,406.68
Amount expended during the month	45.00	....	10,134.06	1,323.55	215.00
	4,838.98	19,008.51	128,935.63	111,814.63	20,621.68
Balance unexpended at end of month	207.54	991.49	49,716.89	16,023.32	1,237.03
In Treasury United States	....	....	49,000.00	10,000.00	....
In hand	207.54	991.49	716.89	6,023.32	1,237.03
	207.54	991.49	49,716.89	16,023.32	1,237.03
Outstanding liabilities at end of month	207.54	....	1,000.00	300.00	500.00
Amount covered by existing contracts at end of month	....	991.49	38,591.14	....	....
	207.54	991.49	39,591.14	300.00	500.00
Balance available at end of month	....	....	10,125.75	15,723.82	787.03

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1904—Continued.

FIRST AND SECOND DISTRICTS—Continued.

	Improving Mississippi River, allotment for—				
	Upper Yazoo levee district.	Plum Point Reach.	Dikes.	Plant.	At Hickman, Ky.
Amount expended on present project to end of last fiscal year	$1,191,989.93	$5,123,882.62	$53,809.92	$882,614.20	$94,327.87
Balance unexpended at end of last fiscal year	44,361.85	2,778.00	1,114.50	41,085.78	804.13
Amount appropriated or allotted since (net)	70,000.00	69,000.00	....	70,260.00	....
	114,361.85	71,778.00	1,114.50	111,345.78	804.13
Amount expended from beginning of present fiscal year to end of previous month	67,269.72	69,916.95	1,035.10	102,735.34	....
Amount expended during the month	939.89	1,514.06	79.40	6,200.19	....
	68,209.61	71,431.01	1,114.50	108,935.53	....
Balance unexpended at end of month	46,152.24	346.99	....	2,410.25	804.13
In Treasury United States	42,000.00	....	....	260.00	....
In hand	4,152.24	346.99	....	2,150.25	804.13
	46,152.24	346.99	....	2,410.25	804.13
Outstanding liabilities at end of month	1,500.00	346.99	....	2,410.25	....
Amount covered by existing contracts at end of month	42,967.23	....	....	....	....
	44,467.23	346.99	....	2,410.25	....
Balance available at end of month	1,685.01	....	....	....	804.13

	Improving Mississippi River, allotment for—				
	At New Madrid, Mo.	Caruthersville, Mo.	Hopefield Bend (preservation of works at).	At Memphis, Tenn.	At Helena, Ark.
Amount expended on present project to end of last fiscal year	$150,209.09	$74,611.80	$127,692.07	$44,622.10	$203,716.60
Balance unexpended at end of last fiscal year	1,790.91	388.20	2,307.93	377.90	1,783.40
Amount appropriated or allotted since (net)	....	....	99,000.00	....	5,000.00
	1,790.91	388.20	101,307.93	377.90	6,783.40
Amount expended from beginning of present fiscal year to end of previous month	103.80	209.22	101,250.04	....	6,436.74
Amount expended during the month	....	....	....	....	....
	103.80	209.22	101,250.04	....	6,436.74
Balance unexpended at end of month	1,687.11	178.98	57.89	377.90	346.66
In Treasury United States	....	....	....	....	....
In hand	1,687.11	178.98	57.89	377.90	346.66
	1,687.11	178.98	57.89	377.90	346.66
Outstanding liabilities at end of month	....	....	57.89	....	....
Amount covered by existing contracts at end of month	....	....	....	....	....
	....	....	57.89	....	....
Balance available at end of month	1,687.11	178.98	....	377.90	346.66

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1904—Continued.

FIRST AND SECOND DISTRICTS—Continued.

	Improving Mississippi River, allotment for—			Repairing Government levee at Walnut Bend, Ark.	Grand total.
	Improving harbor at Memphis, Tenn. (Wolf River).	Expended allotments.	Total.		
Amount expended on present project to end of last fiscal year	$6,272.45	[a]$2,068,953.78	$12,211,141.44	$1,286.06	$12,212,427.50
Balance unexpended at end of last fiscal year	3,727.55	....	193,915.85	88,713.94	282,629.79
Amount appropriated or allotted since (net)	8,000.00	....	581,260.00	....	581,260.00
	11,727.55	....	775,175.85	88,713.94	863,889.79
Amount expended from beginning of present fiscal year to end of previous month	7,752.96	....	630,211.69	2,592.16	632,803.85
Amount expended during the month	60.00	....	20,511.15	1,132.06	21,643.21
	7,812.96	....	650,722.84	3,724.22	654,447.06
Balance unexpended at end of month	3,914.59	....	124,453.01	84,989.72	209,442.73
In Treasury United States	3,000.00	....	104,260.00	84,000.00	188,260.00
In hand	914.59	....	20,193.01	989.72	21,182.73
	3,914.59	....	124,453.01	84,989.72	209,442.73
Outstanding liabilities at end of month	....	....	6,322.67	800.00	7,122.67
Amount covered by existing contracts at end of month	....	....	82,549.86	....	82,549.86
	....	....	88,872.53	800.00	89,672.53
Balance available at end of month	3,914.59	....	35,580.48	84,189.72	119,770.20

[a] Preservation of works, $54,867.89; Walnut Bend levee, preservation of works at, $28,200; removal of Nonconnah Rock, $9,000; dredges and dredging, $388,097.12; Columbus, Ky., $43,750; improving St. Francis River (Walnut Bend levee), $75,000; improving harbor at Memphis, Tenn., $1,425,038.77; improving harbor at Memphis, Tenn. (Wolf River), $45,000.

THIRD DISTRICT.

[Appropriation: Improving Mississippi River.]

	Improving Mississippi River, allotment for—				
	Surveys.	Lower Yazoo levee district.	Upper Tensas levee district.	Ashbrook Neck.	Lake Providence reach.
Amount expended on present project to end of last fiscal year	$87,255.49	$3,095,338.88	$4,349,145.18	$614,680.69	$3,796,596.54
Balance unexpended at end of last fiscal year	673.83	125,903.51	51,012.62	1,095.76	297.46
Amount appropriated or allotted since (net)	5,000.00	291,000.00	112,500.00	36,000.00	25,000.00
	5,673.83	416,903.51	163,512.62	37,095.76	25,297.46
Amount expended from beginning of present fiscal year to end of previous month	5,671.14	371,139.63	144,654.02	37,027.85	25,258.71
Amount expended during the month	2.09	776.80	1,621.70	52.90	....
	5,673.23	371,916.43	146,275.72	37,080.75	25,258.71

Consolidated statement of condition of appropriations and allotments under Mississipp River Commission on June 30, 1904—Continued.

THIRD DISTRICT—Continued.

	Improving Mississippi River, allotment for—				
	Surveys.	Lower Yazoo levee district.	Upper Tensas levee district.	Ashbrook Neck.	Lake Providence reach.
alance unexpended at end of month	$0.60	$44,987.08	$17,236.90	$15.01	$38.75
In Treasury United States		29,995.46	15,000.00		
In hand	.60	14,991.62	2,236.90	15.01	38.75
	.60	44,987.08	17,236.90	15.01	38.75
Outstanding liabilities at end of month	.60	1,500.00	2,600.00	15.01	38.75
Amount covered by existing contracts at end of month		40,000.00			
	.60	41,500.00	2,600.00	15.01	38.75
Balance available at end of month		3,487.08	14,636.90		

	Improving Mississippi River, allotment for—					
	Stone.	General repairs to existing works.	Plant.	Greenville, Miss.	Expended allotments.	Total.
Amount expended on present project to end of last fiscal year	$259,081.26		$842,985.93	$898,919.50	[a]$780,281.74	$14,724,285.21
Balance unexpended at end of last fiscal year	12,018.74	$9,059.65	87,014.52	7,633.57		294,709.66
Amount appropriated or allotted since (net)		1,000.00	81,350.00	11,000.00		562,850.00
	12,018.74	10,059.65	168,364.52	18,633.57		857,559.66
Amount expended from beginning of present fiscal year to end of previous month	10,216.01	9,959.53	116,532.78	18,252.25		738,711.92
Amount expended during the month	34.47	100.12	18,386.55	201.00		21,175.63
	10,250.48	[b]10,059.65	134,919.33	18,453.25		759,887.55
Balance unexpended at end of month	1,768.26		33,445.19	180.32		97,672.11
In Treasury United States	1,200.00		25,350.00			71,545.46
In hand	568.26		8,095.19	180.32		26,126.65
	1,768.26		33,445.19	180.32		97,672.11
Outstanding liabilities at end of month	100.00		4,000.00	104.50		8,358.86
Amount covered by existing contracts at end of month			22,428.00			62,428.00
	100.00		26,428.00	104.50		70,786.86
Balance available at end of month	1,668.26		7,017.19	75.82		26,885.25

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[a] Lake Bolivar front, $151,300.76; improving harbor at Vicksburg, Miss., $442,724.77; Delta Point, Louisiana, $86,156.21.

[b] Distributed as follows: Surveys, $442.55; Ashbrook neck, $416.67; Lake Providence reach, $,727.62; Lake Bolivar front, $472.81.

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1904—Continued.

FOURTH DISTRICT.

[Appropriations: Improving Mississippi River; improving harbor of Natchez and Vidalia, Miss. and La.; improving harbor of New Orleans, La.; improving Atchafalaya and Red rivers, La.]

	Improving Mississippi River, allotment for—				
	Surveys, gauges, and observations.	Lower Tensas levee district.	Atchafalaya levee district.	Lafourche levee district.	**Barataria levee district.**
Amount expended on present project to end of last fiscal year	$96,137.14	$2,543,414.32	$1,431,175.06	$558,635.28	**$336,166.84**
Balance unexpended at end of last fiscal year	....	24,634.62	33,934.60	17,848.64	**8,566.03**
Amount appropriated or allotted since (net)	6,000.00	110,000.00	40,000.00	20,000.00	**10,000.00**
	6,000.00	134,634.62	73,934.60	37,848.64	**18,566.03**
Amount expended from beginning of present fiscal year to end of previous month	4,908.97	100,823.01	18,348.35	23,873.12	**8,188.78**
Amount expended during the month	10.00	715.78	2,798.35	2,919.01	**1,116.27**
	4,918.97	101,538.79	21,146.70	26,792.13	**9,305.05**
Balance unexpended at end of month	1,081.03	33,095.83	52,787.90	11,056.51	**9,260.98**
In Treasury United States	....	17,500.00	45,000.00	2,000.00	**5,000.00**
In hand	1,081.03	15,595.83	7,787.90	9,056.51	**4,260.98**
	1,081.03	33,095.83	52,787.90	11,056.51	**9,260.98**
Outstanding liabilities at end of month	....	123.75	170.00	82.50	**196.34**
Amount covered by existing contracts at end of month	....	15,072.76	48,164.83	5,804.87	....
	....	15,196.51	48,334.83	5,887.37	**196.34**
Balance available at end of month	1,081.03	17,899.32	4,453.07	5,169.14	**9,064.64**

	Improving Mississippi River, allotment for—				
	Pontchartrain levee district.	Lake Borgne levee district.	Bondurant.	Kempe Bend revetment.	**Plant.**
Amount expended on present project to end of last fiscal year	$1,202,687.43	$305,374.12	$30,000.00	$390,000.00	**$199,170.81**
Balance unexpended at end of last fiscal year	21,647.05	1,821.01	....	....	**67,370.50**
Amount appropriated or allotted since (net)	81,500.00	10,000.00	5,000.00	94,000.00	**[a]30,369.74**
	103,147.05	11,821.01	5,000.00	94,000.00	**97,740.24**
Amount expended from beginning of present fiscal year to end of previous month	64,047.26	9,577.83	5,000.00	89,778.13	**45,879.13**
Amount expended during the month	66.67	357.19	....	1,216.67	**6,904.96**
	64,113.93	9,935.02	5,000.00	90,994.80	**52,784.09**

[a] Includes $12.60 received from sale of condemned engineer property under the provisions of section 5 of river and harbor act of June 13, 1902, allotted by Mississippi River Commission by indorsement of May 25, 1904, approved by Secretary of War June 20, 1904.

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1904—Continued.

FOURTH DISTRICT—Continued.

	Improving Mississippi River, allotment for—Continued.				
	Pontchartrain levee district.	Lake Borgne levee district.	Bondurant.	Kempe Bend revetment.	Plant.
Balance unexpended at end of month.	$39,033.12	$1,885.99		$3,005.20	$44,956.15
In Treasury United States	31,500.00				30,369.74
In hand	7,533.12	1,885.99		3,005.20	14,586.41
	39,033.12	1,885.99		3,005.20	44,956.15
Outstanding liabilities at end of month	172.03	1,006.57		1,088.93	1,834.37
Amount covered by existing contracts at end of month	38,861.09				42,800.00
	39,033.12	1,006.57		1,088.93	44,634.37
Balance available at end of month		879.42		1,916.27	321.78

	Improving Mississippi River, allotment for—				
	Natchez and Vidalia harbors, Miss. and La.	New Orleans Harbor, La.	Atchafalaya and Red rivers, La.	Expended allotments.	Total.
Amount expended on present project to end of last fiscal year	$320,000.00	$41,137.59	$10,529.56	a $136,506.99	$7,600,934.64
Balance unexpended at end of last fiscal year		72,612.41	4,470.44		252,905.30
Amount appropriated or allotted since (net)	12,000.00				418,869.74
	12,000.00	72,612.41	4,470.44		671,775.04
Amount expended from beginning of present fiscal year to end of previous month	10,992.29	66,448.08	2,196.58		450,061.53
Amount expended during the month.	357.35		265.00		16,727.25
	11,349.64	66,448.08	2,461.58		466,788.78
Balance unexpended at end of month.	650.36	6,164.33	2,008.86		204,986.26
In Treasury United States					131,369.74
In hand	650.36	6,164.33	2,008.86		73,616.52
	650.36	6,164.33	2,008.86		204,986.26
Outstanding liabilities at end of month	129.19	955.94	61.88		5,821.50
Amount covered by existing contracts at end of month					150,703.55
	129.19	955.94	61.88		156,525.05
Balance available at end of month	521.17	5,208.39	1,946.98		48,461.21

Preservation of Works, $134,000; Dredges and Dredging, $2,506.99.

Consolidated statement of condition of appropriations and allotments under ***Mississippi*** *River Commission on June 30, 1904*—Continued.

FOURTH DISTRICT—Continued.

	Improving harbor of Natchez and Vidalia, Miss. and La.	Improving harbor of New Orleans, La.	Improving Atchafalaya and Red rivers, La.	**Grand total.**
Amount expended on present project to end of last fiscal year	$282,252.04	$979,639.86	$1,001,709.40	**$9,864,535.94**
Balance unexpended at end of last fiscal year				**252,905.30**
Amount appropriated or allotted since (net)				**418,869.74**
				671,775.04
Amount expended from beginning of present fiscal year to end of previous month				**450,061.53**
Amount expended during the month				**16,727.25**
				466,788.78
Balance unexpended at end of month				**204,986.26**
In Treasury United States				**131,369.74**
In hand				**73,616.52**
				204,986.26
Outstanding liabilities at end of month				**5,821.50**
Amount covered by existing contracts at end of month				**150,703.55**
				156,525.05
Balance available at end of month				**48,461.21**

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APPENDIX 1.

REPORT OF CAPT. WM. B. LADUE, CORPS OF ENGINEERS, SECRETARY MISSISSIPPI RIVER COMMISSION.

MISSISSIPPI RIVER COMMISSION,
OFFICE OF THE SECRETARY,
St. Louis, Mo., May 31, 1904.

COLONEL: I have the honor to submit the following report of operations under this office for the year ending May 31, 1904:

The work in charge of the secretary of the Mississippi River Commission is carried on under allotments made by the Commission from appropriations for improving the Mississippi River between the Head of the Passes and the mouth of the Ohio River, under allotment for fiscal year from permanent appropriation provided by section 9 of the river and harbor act of June 13, 1902, for gauging the waters of the Mississippi River, and its tributaries, and under appropriation in river and harbor act of June 13, 1902, for surveys and examinations from mouth of Illinois River to St. Louis to determine the feasibility of navigable waterway 14 feet in depth.

The allotments from the first-named appropriation are as follows:

(1) *Mississippi River Commission.*—Available for salaries, clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission.

(2) *Surveys, gauges, and observations.*—Available for survey of the Mississippi River between the Head of the Passes and its headwaters, for the establishment and maintenance of gauges, for special surveys and examinations, and for the collection and reduction of physical data pertaining to the Mississippi River.

(3) *Dredges and dredging.*—Available for the construction, operation, and maintenance of dredging plant for the Mississippi River from Head of the Passes to the mouth of the Ohio River.

The allotment from the permanent appropriation for gauging is available for paying gauge observers and other expenses incident to maintaining gauges at specified places on the Mississippi River and its tributaries.

The appropriation for survey from mouth of Illinois River to St. Louis, in connection with deep waterway survey from Lockport, Ill., to St. Louis, Mo., is available for surveys, borings, discharge measurements, and reduction and platting of same.

MISSISSIPPI RIVER COMMISSION.

The Mississippi River Commission held three sessions during the year, as follows:

Eighty-ninth session, June 24–27, 1903, at St. Louis, Mo.

Ninetieth and ninety-first sessions on board the United States steamer *Mississippi*, St. Louis, Mo., to New Orleans, La., November 7–17, 1903, and March 10–18, 1904, respectively.

Plant and outfit.—The steamer *Mississippi* has been in service with the Commission on its inspection trips, and also made a trip to Cairo early in January, 1904, to bring down two barges of coal. From July 30 to October 17, 1903, she was docked in the lock of the Louisville and Portland Canal, at Louisville, Ky., and the after half of her hull replated, stern rake remodeled and two new balanced rudders and steam steering gear installed, under emergency contract with Henry Vogt Machine Company. During the balance of the time the boat has been laid up at West Memphis, Ark., where repairs to steam and water pipes were made, capstan engine and doctor overhauled, and a new lavatory put in and connected. Repairs have also been made to the roof, and the woodwork of the cabin and texas where necessary.

SURVEYS, GAUGES AND OBSERVATIONS.

Survey of the Mississippi River.—This survey, which is authorized by the law creating the Mississippi River Commission, to extend from Head of the Passes to the headwaters of the river, has been made with the view of obtaining accurate data for topographical and hydrographical maps for use in study of the river in connection with planning improvements. The most approved methods have mainly been used in this work.

The field work comprises secondary triangulation, precise levels, topography, and hydrography. The instructions to field parties for this work will be found in the Report of the Chief of Engineers for 1891, pages 3474–3485; the instructions for precise leveling, as revised, will be found in the Report of the Chief of Engineers for 1899, pages 3469–3474.

A summary of the surveys to 1896 is printed in the Report of the Chief of Engineers for 1896, pages 3574–3576; the progress of the work since will be found in succeeding annual reports. The condition of the work at the beginning of the present year will be found in the Supplement to the Report of the Chief of Engineers for 1903, pages 60–63.

The secondary triangulation now covers the entire river from Head of the Passes to the headwaters at Lake Itasca (1,275[a]), a distance by river of about 2,347 miles. The triangulation follows the river to Aitkin, Minn. (1,086[a]). From Brainerd, Minn., about 55 miles below Aitkin, it is carried directly across country to Lake Itasca and thence down the river to Lake Bemidji. From Lake Bemidji a base line, whose length and azimuth are accurately determined, has been carried along the railroad to Aitkin, thus forming a loop. This base line forms the basis of the topographic and hydrographic work along the river. The precise levels also cover the entire river and generally follow the same lines as the triangulation, but extend down to the end of the jetties at the mouth of South Pass.

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[a] Miles above Cairo.

A map showing the river from Brainerd, Minn., to Lake Itasca, with the triangulation, measured base, and precise level lines, will be found in the Supplement to the Report of the Chief of Engineers for 1901, plate 1, opposite page 232.

The lines of precise levels on the lower river were rerun in 1899 as far north as Fort Adams, Miss., and an account of the results is printed in the Report of the Chief of Engineers for 1900, page 4559. The extension of this releveling northward until the disappearance of the discrepancy found to exist between the earlier and later lines is contemplated.

The topography and hydrography of the river are completed from Head of the Passes to Pokegama Dam, Minn., a river distance of about 2,230 miles. This work is also completed over the Itasca Basin and a portion of the river in that vicinity. A party is now in the field closing the gap between Pokegama Dam and Itasca Basin.

Low water survey, Cairo to mouth Arkansas River.—This survey was undertaken in compliance with resolution of the Mississippi River Commission, June 26, 1902, to determine the present shore line and to furnish other data for a new edition of inch-to-mile maps for this stretch of the river, the first edition made from surveys of twenty years ago having been in part exhausted. The field work of this survey was completed in 1902 from Cairo, Ill., to Corona Landing, Ark. (203). Owing to unfavorable stages of water, the work was not resumed in 1903.

WORK DURING THE YEAR.

General survey work.—The party which was in the field at the date of the last annual report closed its work for the season at Pokegama Dam June 10, 1903, and disbanded.

A party was organized early in January, 1904, for the topographical survey above Pokegama Dam (1,168[a]), and field work was begun January 15. The party, as now organized, consists of Assistant Engineer W. G. Comber, chief of party; Messrs. George H. French, E. J. Thomas, George H. Wolbrecht, and Gragg Richards, topographers; and Mr. Fred A. Snyder, levelman; with recorders, surveymen, cooks, laborers, teamsters, etc.; in all about 40 persons, with 5 teams.

A steel tape base line has been carried up the river, checking wherever possible on the base line along the railroad from Bemidji to Grand Rapids. Detailed topography, shore lines, levels, and soundings have been carried up the river, and have included Ball Club Lake, Winnebigoshish and Little Winnebigoshish lakes, Cass Lake and Wolf Lake. Soundings were made through the ice, using an ice-boring machine and sounding outfit borrowed from the United States Engineer office at Duluth, Minn. This work is now approaching Lake Bemidji, and it is hoped that the field work will be completed this season to join with the work already done, and so complete this survey to the headwaters of the river.

Survey of Rodney and Kempe bends (miles 651 to 660).—This survey was undertaken in compliance with resolution of the Mississippi River Commission, November 13, 1903. A party in charge of Mr. E. L. Harman, with the steamer *Patrol*, began the field work on November 18, and completed the survey on December 8. The notes were reduced in the office and platted on a scale of 1:5,000, the work being completed in the latter part of January, 1904.

Hydrographic resurvey from Forts Jackson and St. Philip to Head of the Passes.—This survey was undertaken in compliance with resolution of the Mississippi River Commission, June 24, 1903. A party in charge of Assistant Engineer A. T. Morrow, with the steamer *Patrol*, began the field work at the forts on December 26, 1903, and completed the survey to Head of the Passes, January 18, 1904. The river distance covered was about 21 miles, and the work was extended about one-half mile down each of the passes and about one-fourth mile down the Gap, the Jump, and Baptiste Collets Canal. On this survey many of the iron benchmarks along the river, being found badly corroded, were replaced by creosoted posts.

Plant and outfit.—The floating plant now consists practically of the steamer *Patrol* and quarterboat *Illinois*, with some small boats and skiffs. This plant, when not in field service, has been cared for at West Memphis. Some repairs were made to the *Patrol*, and new boilers were installed during the year. New steel cylinder beams have been purchased, and an emergency contract entered into with Mr. Ed. J. Howard, of Jeffersonville, Ind., for extensive repairs to her hull. The boat has been sent to Paducah, Ky., for this work.

Reduction and platting of field notes.—The reduction and platting of field notes of the topography and hydrography of the season of 1901, in the vicinity of Aitkin, Minn., were completed.

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[a] Miles above Cairo.

The reduction of the field notes of the topography and hydrography of the season of 1903, between Aitkin, Minn., and Pokegama Dam, was completed, and progress made in the platting.

Progress was made in platting the field notes of the low-water survey from Cairo to Corona Landing, season of 1902.

The field notes of the survey of Rodney and Kempe bends were reduced and platted.

The field notes of the hydrographic resurvey below the forts were reduced, and the platting nearly completed.

Mapping.—Detail charts Nos. 219 to 224, inclusive, above Minneapolis, Minn., scale 1:5,000 were completed. Progress was made on charts Nos. 225 to 233 of the same series; chart No. 233 extends this work to about 4 miles above Aitkin, Minn.

Maps Nos. 131 to 135, inclusive, inch to the mile series, were completed and progress made on No. 136. Map No. 136 includes the cities of St. Paul and Minneapolis.

The map of the St. Francis Basin, in two sheets, scale 1 inch to 1 mile, was completed by the addition of all available data.

Published maps and charts.—Detail charts Nos. 213 to 218, inclusive, were published to a scale of 1:10,000. This extends this series from Minneapolis, Minn., to about 10 miles below Little Falls, Minn. (992.3[a]).

A title sheet and an index map in two sheets, for the series of detail charts from Cairo to Minneapolis, were published.

Maps Nos. 131 to 135, inch to the mile series, were published. These extend to the lower limits of the city of St. Paul, Minn.

The map of the St. Francis Basin, in two sheets, was published to a scale of one-half inch to the mile.

A second edition of 500 copies of the Itasca Basin map, in colors, was published. The scale is 1:15,000.

A list of the maps and charts published by the Commission, together with the regulations relative to their free issue to certain persons, may be found on page 35 of the supplement to the Annual Report of the Chief of Engineers for 1902.

Gauges.—The permanent gauges, the high water gauges, and the tide gauges have been maintained during the year. The permanent gauges have been twice inspected during the year, as prescribed by the Commission, gauges and bulletins being repaired and left in good order. Special inspections were made of gauges at Mhoons Landing (276) and mouth of White River (393).

There are 38 permanent gauges, comprising 17 established by the Commission, and 21 received by transfer from the United States Engineer Office at Vicksburg in 1901. They are distributed as follows: 25 on the Mississippi River from St. Louis, Mo., to Fort Jackson, La.; 1 on Atchafalaya River; 1 each on Arkansas, Cumberland, Tennessee, and St. Francis Rivers; 3 on the Red River; 3 (including Cairo) on the Ohio River; 2 on the White River. The gauges established by the Mississippi River Commission are maintained by allotments from the appropriation for "Improving Mississippi River from Head of Passes to the mouth of the Ohio River;" the others, by allotments from the permanent appropriation for "Gauging the Waters of the Mississippi River and its Principal Tributaries," established by acts of August 11, 1888, and June 13, 1902. A description of these gauges is printed in supplement to report of the Chief of Engineers for 1902, pages 52 to 59.

The highest and lowest readings on the permanent gauges during 1903 are given in Table No. 1, with the previous highest and lowest for comparison. The highest readings on the gauges on the tributaries, for 1904 to May 31, are given in Table No. 3. A hydrograph showing the daily stages of the main river from Cairo to Fort Jackson, from June 1, 1903, to May 31, 1904, is given on plate 2.

A new inclined gauge of concrete with a steel beam embedded has been constructed on the levee slope at Memphis, Tenn. The graduations and figures have been marked in the steel of the St. Louis gauge. The gauges at Cairo and Memphis will be marked in a similar manner next season. The high water of 1903 at St. Louis, which read 38 feet on the gauge, has been permanently marked on the gauge.

New bulletins have been erected at Donaldsonville, La., Red River Landing, La., and Vicksburg, Miss.

A gauge has been maintained at Aitkin, Minn., in connection with the survey of the upper Mississippi.

High-water gauges.—The high-water gauges are 185 in number, distributed on the Mississippi River from Cairo to the Head of the Passes, about 5 miles apart. These gauges are read at times of highest water only, and supplement the regular gauges in determining the high-water slope of the river. They were inspected and put in order previous to the high water this spring. The maximum readings on these gauges during the high water of 1904 are given in Table No. 2. A profile of the main river from Cairo to Head of the Passes is shown on plate 3.

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[a] Miles above Cairo.

Tide gauges.—The tide gauges at Biloxi, Miss., and East Bay, La., have been maintained in good order, and continuous records for the year secured. The staff gauges were connected with their bench marks by precise levels in January, 1904. The reduction of the records since 1899 is now in progress, and the results will be published when the reduction is completed.

Discharge observations.—The resolution of the Mississippi River Commission governing the measurement of the high and low water discharges of the Mississippi River and its tributaries may be found on page 36 of the Supplement to Report of the Chief of Engineers for 1902.

During the high water of June, 1903, the discharge of the Mississippi River was measured at Grafton, Ill., and Thebes, Ill., by two parties, in charge of Assistant Engineer A. T. Morrow and Junior Engineer E. L. Harman, respectively. The discharge of the Arkansas River at Little Rock, Ark., was measured about the same time by a party in charge of Assistant Engineer William Gerig. All these discharges were taken at the highest stages reached. The results were published in Table No. 7, on pages 111, 112, and 119 of the Supplement to the Report of the Chief of Engineers for 1903.

During the low-water season of 1903 the discharge of the Tennessee and the Cumberland rivers was measured by a party in charge of Mr. M. A. Bell. Both discharges were taken at the lowest stage reached, which was below the prescribed discharge stage. The prescribed stage for low-water discharge measurements on the Mississippi was reached at Columbus, Ky., for part of one day, December 20, when a reading of 2.99 was recorded, and at Carrollton, La., from December 28 to 31, the minimum reading being —0.1. No discharge observations were made, however, the river being closed by ice at Columbus, and the time during which the low readings were recorded at both stations being too short to permit getting a party to the spot.

During the high water of 1904, the discharge of the Mississippi River was measured at Thebes, Ill., Columbus, Ky., Helena and Arkansas City, Ark., Vicksburg, Miss., and Red River Landing and Carrollton, La. The discharge of the Atchafalaya was measured at Simmesport, La. All these discharges were taken at the highest stages reached. Three parties were in the field, in charge of Assistant Engineer William Gerig, Junior Engineer E. L. Harman, and Mr. M. A. Bell. Double floats and Haskell and Price meters were used.

All meters were carefully rated in the settling basin of the St. Louis waterworks during the summer of 1903. Each meter was again rated after being used for discharge work.

The results of all discharge measurements and meter ratings made during the low-water season are published in Tables 4 and 5.

For additional details of gauge inspections and discharge work attention is invited to report of Assistant Engineer Kivas Tully, Appendix 1 B.

DREDGES AND DREDGING.

Project.—On the 20th of June, 1896, the Mississippi River Commission adopted a project for obtaining and maintaining, by means of dredges, a channel in the Mississippi River below Cairo with a width of 250 feet and a depth of at least 9 feet throughout the year, except when the river is closed by ice. This project provided for the construction and operation of 7 hydraulic dredges by the 30th of June, 1900, and for the provisional construction of 2 others if found necessary.

The building of this plant has formed a very important part of the work of this office, and has involved the preparation of plans and specifications for the dredges themselves, for the necessary large and small tenders, pile sinkers, and other plant. Since the beginning of the construction of this dredging plant many changes have taken place in the method pursued to procure the most efficient and best-designed dredges.

The first dredge was built after plans prepared by the dredging committee and was in the nature of an experiment. While many changes in this boat were afterwards found necessary, it yet demonstrated beyond a doubt the efficiency of such hydraulic dredges for the purpose for which it was designed.

The next step was to define, in general terms, the conditions which the dredges must fulfill, leaving to the builders the details of the design. Following this course 3 dredges were built. Experience was constantly gained until a point was reached where it was [illegible]le to outline with greater accuracy nearly all the details of construction. U[illegible]h specifications 2 more dredges were built. Under still more rigidly drawn specifications another, the seventh, a self-propelling dredge, was placed under contract in 1898. This dredge was completed and delivered to the United States in August, 1900. The eighth and ninth dredges, also self-propelling, were placed under contract in June, 1899, and were completed and delivered to the United States in July, 1901. In June, 1902, the *Alpha* having become unserviceable, the construction of a tenth dredge, to be self-propelling, was decided upon. Plans, specifications, and drawings have been prepared and the work advertised.

CONSTRUCTION, ALTERATION, AND REPAIRS TO PLANT.

Dredge Alpha.—The machinery of this dredge has been transferred to other officers in accordance with resolution of Mississippi River Commission, June 26, 1902.

Dredge Beta.—This dredge was returned to the fleet by the officer in charge of the work at South Pass on September 28, 1903. In December, 1903, instructions were received to prepare the dredge again for service at South Pass and to lengthen the suction to permit dredging to a depth of 35 feet. By authority of the Chief of Engineers the necessary alterations and repairs required to fit the dredge for this work were made by this office, the cost being paid by the engineer officer in charge of the work at South Pass. Under this arrangement the suction and jet pipes were lengthened 6 feet, new hose connections for the jet pipes and new rubber joints for the discharge pipes procured, new fair-leader rolls provided, and repairs made to engines, furnaces, pumps, and roof. Other repairs of a more general character were made at the same time and paid for by this office. The discharge pipes, being badly worn on the bottom, were turned over in the pontons, and the end rings of each section, where the greatest wear had occurred, replaced by new iron. The pontons and pipes were then sand blasted and painted in part. This work will be completed before the dredge again takes the field. The dredge was ready for service by April 1, 1904, but she has not yet been required for use by the engineer officer in charge of the work at South Pass.

Dredge Gamma.—This dredge was not in commission during the year, and only minor repairs, required to keep her in good condition, were made.

Dredge Delta.—Additional supports for the foundation of the main engine were put in and the main engine thoroughly overhauled. Repairs were made to feed pumps, boilers, furnaces, woodwork, and floors, and towing knees placed on forward deck. New edge plates have been put on main pump runner, cast with a chill in the hope of reducing wear. The lining of the pump casing has been renewed, the old lining having been worn entirely through in places. The suction pipes to jet pump are being moved to take water farther aft, out of the way of sand stirred up by the jets. As stated in my last annual report, this dredge proved difficult to control when dredging downstream, owing to the fact that the winding engines were not reversing. To obviate this difficulty the engines were made reversing, and the results were very satisfactory. When working in sand the rate of progress is found to be practically the same for both up and down stream work, with the advantage in favor of the downstream dredging that all material stirred up by the jets is removed from the cut, which is not always the case in dredging upstream. In large and heavy gravel, however, such as was encountered at Presidents Island (234), the method of downstream dredging could not be used, the suction head being unable to penetrate the material.

Dredge Epsilon.—Various minor repairs were made to this dredge.

Dredge Zeta.—The main pump runner (7 blades) is being converted into a shrouded runner. The experience gained with runners of this type on the *Epsilon*, *Iota*, and subsequent dredges indicates that efficiency and economy will be promoted by this change. Minor repairs have been made.

Dredge Iota.—Tests of the main pump of this dredge, after the runner was shrouded, showed an increase of about 10 per cent in both efficiency and capacity at the standard speed, thus illustrating anew the advantages of this type of runner. A traveling crane for handling the main pump and engines has been installed and various repairs made to machinery, steam lines, and cabins. A new feed water heater of the horizontal closed tubular type was installed.

Dredges Kappa and Henry Flad.—Repairs were made to the main steam line, feed pumps, feed water pipes, universal joints of discharge pipe, and lighting system. New feed water heaters similar to that on the *Iota* were installed. The shrouds of the main pump runners were set out one-fourth inch to take up wear. Hatches have been enlarged, and additional small hatches cut to facilitate entrance to the holds and ventilation. A drain tank has been put in the hold of each dredge, into which the drips, drains, and cylinder cocks from the various pumps and engines discharge. While the *Kappa* was working at the foot of Island 21 (131) September 10, 1903, the connecting rod of the starboard main engine broke, completely wrecking that engine. The damage was repaired at the fleet, and the engines lined up. On January 29, 1904, fire was discovered under the pilot house of the *Kappa*, but it was quickly extinguished and the damage, which was slight, has been repaired. The cabin of the *Kappa* was painted, and the insides of the wheel houses of the *Henry Flad* were coated with coal tar. Other minor repairs were made.

Dredge B. M. Harrod.—The plans and specifications for this dredge have been completed, and the work advertised. This dredge, like the other later dredges, will be self-propelling. The detailed specifications are given in Appendix 1 E.

Steamers Sachem, Choctaw, Nokomis, Wynoka, and Leota.—These boats are used as towboats and tenders for the nonpropelling dredges. The work of altering the boilers of the *Choctaw* and the *Nokomis*, which was in progress at the date of my last annual report, has been finished, and the same alterations have been made on the steamer *Sachem*. The results have been very satisfactory, no further trouble having been experienced. The feed pumps on all these boats have been moved from their original location in the boiler room to the engine room and new feed water heaters of the closed type, and of simple construction, have been made and erected. The Wheeler heater erected last year on the *Wynoka* will be placed on the dredge *Gamma*. The furnaces of the *Sachem*, *Choctaw*, *Nokomis*, and *Leota* have been rebuilt, and new stacks erected and new wheels made for the last three. The samson posts and braces on the *Sachem* and *Nokomis* have been extended to the roof, as was previously done on the other tenders. The cylinders of both main engines on the *Sachem*, and of one each on the *Nokomis* and *Wynoka*, have been rebored, new roofs of asbestos roofing have been placed on the *Sachem* and the *Choctaw*, and new canvas on the boiler deck of the latter boat and the *Leota*. The ice machine of the *Leota* has been overhauled and a new steam steering gear installed, the one originally furnished having proved unsatisfactory. The *Wynoka* returned to the fleet July 2, 1903, from Jeffersonville, Ind., where a new cabin and upper works had been built under contract with Mr. Ed. J. Howard. All the work of connecting up the pipes and machinery was done at the fleet. Other minor repairs were made, and painting done on all these boats, as required.

Steamer Minnetonka.—This boat is unserviceable at present, and little or nothing has been done to her this year. Contract has been made with Mr. Ed. J. Howard for the rebuilding of her hull, and she has been sent to Paducah, Ky., for this work.

Steamer Search.—The rebuilding of the hull, which was in progress at the date of my last annual report, was completed and the boat painted inside and out. New steel cylinder beams have been put in and minor repairs made.

Steamers Vulcan, Venus, Mercury, and Mars.—General repairs to decks, engines, and woodwork have been made. A new stack has been built for the *Venus*, and a new wheel for the *Mercury*.

Pile sinkers and barges.—General repairs have been made, and the hulls of pile sinkers *No. 971* and *No. 983* have been thoroughly repaired and calked. A new set of leads were built for pile sinker *No. 971*.

Buildings and grounds.—A tract of land at West Memphis, Ark., containing about 9 acres, has been purchased for storage and other uses, and a warehouse and machine shop have been erected.

Permanent outfit.—A steam hammer, lathe, radial drill, planer, and punch, and shears, with the necessary shafting, etc., have been purchased, and the work of installing them in the machine shop is in progress.

For additional details of repairs during the year attention is invited to report of Assistant Engineer F. B. Maltby, Appendix 1 C.

DREDGING OPERATIONS ON THE LOWER MISSISSIPPI RIVER BETWEEN CAIRO, ILL., AND HEAD OF THE PASSES.

These operations include the care and repair of plant, testing of dredges and operation of the plant during the low-water season.

A statement of the general principles which have governed the conduct of dredging operations may be found in the report of the Chief of Engineers, U. S. Army, for 1898, pages 3166–3169, and in the report of the Chief of Engineers, U. S. Army, for 1900, page 4564.

During the low-water season of 1903, six dredges, the *Delta*, the *Epsilon*, the *Zeta*, the *Iota*, the *Kappa*, and the *Henry Flad* were in commission. The *Beta* was returned to the fleet on September 28 by the officer in charge of the work at South Pass, and did not take the field after that date, while the *Gamma* was not put in commission during the season. The dredges were assigned to different stretches of the river. Three survey parties were kept in the field, and surveys were made of all bars where trouble was anticipated. Frequent surveys were made of those bars where dredging was done, to observe the effect of the dredging. These surveys served to determine the areas of shoal water and to enable the location of the channels to be intelligently made. Frequent inspections were made of that part of the river where shoals are known to exist, and all crossings sounded. The greatest possible publicity was given to information obtained, and all channels were located by easily distinguishable marks. By November 30 all the dredges and survey parties were withdrawn from the field, as it was thought that the danger of low water was over for the season. The dredges were compelled to take the field again about December 12, but it was impracticable to organize and send out the survey parties, so the work done in December was not accompanied by surveys.

Dredge Beta.—This dredge was received from the officer in charge of the work at South Pass on September 28, at West Memphis, Ark., where, after tests of her boilers and one of her main pumping units had been made, she was laid up. She did no work under the Commission during the season.

Dredge Gamma.—This dredge was not in commission during the season.

Dredge Delta.—This dredge left the fleet August 27, for Peters Crossing (272), where the shoalest water below Cairo was shown by the surveys. Dredging was begun August 30 and continued with some interruptions for repairs until September 9, when the work was completed. The channel at this time was from 7 to 9 feet deeper than when dredging was begun. During a rise, which culminated about September 21, the dredge lay at the bank. Dredging was resumed on September 28 and continued, with a loss of only fifteen minutes for repairs, until October 5, when work at this locality was completed. There was then a good 16-foot channel over this crossing. The dredge then moved to the head of Presidents Island (234), where dredging was begun October 8 and continued with slight interruptions until October 14, when work was suspended owing to a rising river, and the dredge went to the fleet at West Memphis. The material encountered on this bar is a very coarse cemented gravel, with large pieces of lignite scattered through it, and is very difficult to move with the hydraulic agitators, as well as very hard on the pump. The liner of the main pump casing was found deeply scored and entirely worn through in one place after this work,

The river having fallen again, dredging was resumed at Presidents Island on November 4, but lower down on the reef, where more sand and less gravel were encountered. Some drift was met with, which caused delay. Dredging was continued until November 17 with various interruptions to repair main pump, jet pump, and hauling cables. There was then a good, well-defined channel, 16 feet deep and 250 feet wide. The dredge then went to the fleet, where she remained in commission until December 14, when she left for Random Shot (192), where she arrived the next day. At this time there was not over 7 feet on this bar. Dredging was begun December 15 and continued without serious interruption until December 18, when the work was completed. There was then a good steamboat channel 12 feet deep and 250 feet wide through the bar. About 48,000 cubic yards of material were removed during fifty-nine hours of actual dredging. The dredge then proceeded to the chute of Island 20 (127), where dredging was begun December 22 and continued until December 24, when the work was completed, a good 12-foot channel having been made. The dredge then proceeded to Darnells bar (81), where dredging was begun December 28 and continued until the 29th, when work was stopped on account of a rapid rise in the river There was then a 13-foot channel over the crossing. The dredge then proceeded to Joe Eckles Crossing (93), where about nine hours' work was done, after which the dredge proceeded to West Memphis, Ark., and was laid up January 3, 1904.

Dredge Epsilon.—This dredge left the fleet September 9 for Luxora, Ark. (161), where dredging was begun on September 13 and continued until September 15, when the work was suspended on account of a rising river. On September 29 dredging was begun at Last Chance Crossing (166), and continued until October 2, with a loss of a little more than four hours for repairs. The dredge then moved to Gold Dust Crossing (158), where dredging was begun October 3 and continued until October 6, when the work was completed. There was then 16 feet of water over the bar. Owing to a rise in the river the dredge remained at the bank unable to work until October 21, when she was ordered to the fleet and put out of commission.

Dredge Zeta.—This dredge left the fleet August 14 and began dredging at Joe Eckles bar (92) on August 19 and continued until August 20. Dredging was resumed August 29 and continued until September 2, when the work was completed. A short cut through the lower part of the same reef was made the same day, and the dredge went to the bank to await a lower stage. There was then a 17-foot channel through the bar. On September 15 the dredge was moved to Cherokee Crossing (90), but owing to the high stage no work was done until the 29th, when dredging was resumed and continued, working daylight only, till October 1, when the work was completed. There was then 16½ feet over the crossing. A small amount of work was done October 2 and 3 at Joe Eckles bar (92), after which the dredge remained at the bank until October 10, when she was moved to Hathaway (103). Dredging was begun on October 11 and continued, in daylight watches only, until October 14, after which the dredge went to the bank and remained there, unable to work on account of the stage of the river, until October 22, when she was sent to the fleet. The record of this dredge for the season was excellent, only one and one-half hours being lost for repairs out of two hundred and forty-two hours of dredging.

Dredge Iota.—This dredge left the fleet August 6 and reached Bixbys Towhead (83) August 17, having been assisted from Gayoso (106) by the *Leota*. Dredging was done at this locality August 19 to 20 and August 23 to 25, when work was suspended on account of the high stage of water. Dredging was resumed September 2, but suspended again on the 4th for the same reason. The dredge lay at the bank until September 29, when work was again resumed, and completed October 6, on which date there was 14 feet in the channel. During the work at this point nearly thirty hours were lost in repairs to the swivel elbow at stern of dredge. A high stage prevailed until the latter part of October, and no further work was done until October 28, when dredging was begun below New Madrid, Mo. (70). Dredging was continued until November 3, when work was stopped to repair the jet pump. At this time it was found that an 18-foot channel had broken through the reef a mile and a half above, and work at this point was stopped. The dredge was then moved to Hathaway (103), where dredging was begun November 7, anchors being used for handling the dredge while setting piles, the spud having been broken at New Madrid. This method of handling was slow and unsatisfactory. Work was continued during daylight watches until November 14, when the work was completed. The dredge was then retired from the field, reaching the fleet on November 19.

On December 13 this dredge was again put in commission for work below Memphis, but owing to the shortage of coal she did not leave the fleet. She was laid up January 3, 1904.

Dredge Kappa.—This dredge left the fleet August 19, and began dredging at Hathaway (103) August 26. Work was completed August 30, when there was 16 feet of water in the cut. Dredging was begun at the foot of Island 21 (131) on September 10, and the same day the starboard pumping engine was wrecked by the breaking of the connecting rod and the dredge was sent to the fleet to be repaired. The repairs having been completed, the dredge was put in commission again December 13 and began dredging at Presidents Island (235) the next day. Work was continued until December 19, when operations were suspended because of lack of coal. During this period about a day and a half were lost in rendering assistance to the packet steamer *Delta*, which had grounded above the bar, outside the channel. A coal boat was delivered to the dredge on December 20 and work resumed on the 21st, but the steamer *James Lee* having run into and sunk the coal boat work was again suspended on the same day for want of fuel. As no more coal could be procured at this time the dredge was retired from the field, and was laid up January 3, 1904.

Dredge Henry Flad.—This dredge left the fleet August 26, and was engaged until September 5 in cutting off the lower end of a bar which encroached upon the wharf front at Memphis. This work was successfully accomplished, and the dredge then retired to the fleet, where she lay until September 28. On that date she left the fleet and began dredging at the foot of Island 21 (131) on October 2. The work was completed October 4, and the dredge proceeded to the chute of Island 20 (127), where dredging was begun October 9. The work was completed October 14 with a single crew, and the dredge went to the bank to await a lower stage. On October 22 the dredge left for Bixbys Towhead (83), where dredging was commenced October 28 and continued with interruptions for repairs and cleaning boilers until November 10. Further work was done at this point November 22 to 24, after which the dredge moved to Hathaway (103), where dredging was done November 25 and 26. While the dredge was working at this point the port pile was run into by the steamer *Herman Paepcke* and the upper half broken off and lost.

There being no other place where work could be done at the stage of water then prevailing, the dredge was ordered to the fleet, where she remained in commission until December 11. On that date she again left the fleet for New Haven (162); but, being delayed by the sinking of her coal barge near Craighead Point (171) on the 13th, she did not begin work until the 18th. Work was continued from the 18th to the 20th, considerable time being lost because of high winds and stormy weather, and the dredge then proceeded to Gold Dust crossing (158), where she ran aground on the bar and was detained twenty-four hours. Work was begun on December 21, and completed December 23, a good 12-foot channel having been made through the bar. The dredge then proceeded to the foot of Island 21 (131), where dredging was begun December 24. On December 25 work was suspended in order to repair a burnt boiler, and was not resumed at this point, as the river was rising rapidly and there was a good 12-foot channel. Some work was done clearing out the channel down the shore at New Haven (162) December 29 to 31, and the dredge then proceeded to West Memphis, Ark., and was laid up January 3.

A summary of the dredging operations, distribution of time and expenditures, will be found in Tables 6 and 7. The depths over shoal crossings during the season are given in Table 8.

For further details attention is invited to the report of Assistant Engineer F. B. Maltby (Appendix 1 C).

DISCUSSION OF RESULTS.

The river conditions during the low-water season are shown on the annual hydrograph, plate 2. The limits of the principal fluctuations at Cairo and Memphis between August 1 and December 31 are given in the following table:

CAIRO.

Date.	Reading.	Date.	Reading.
August 1	19.7	October 14	20.5
August 8	16.7	November 28	10.9
August 13	19.5	December 1	12.0
August 30	15.3	December 20	2.8
September 18	20.6	December 29	11.7
September 30	15.9		

MEMPHIS.

Date.	Reading.	Date.	Reading.
August 1	14.3	October 16	13.2
August 10	10.9	November 30	5.6
August 16	12.75	December 4	5.95
September 2	9.6	December 23	.9
September 20	13.5	December 31	5.6
October 2	9.8		

It will be seen that the river did not reach a stage requiring extensive dredging until about December 5, on which date a stage of 10 feet on the Cairo gauge was first reached. At the beginning of the season it was expected that the high water of the spring of 1903 would result in the formation of many obstructing bars, and that conditions requiring extensive dredging operations would early develop. The dredges were accordingly prepared for service, and the survey and inspection parties organized, early in August. Four dredges, the *Delta*, the *Zeta*, the *Iota*, and the *Kappa*, took the field during that month, and two more, the *Epsilon* and the *Henry Flad*, were sent out early in September. During the early part of the season these six dredges were operated wherever it was possible for them to work; but, owing to the high stages prevailing, they were unable to work to the best advantage except at Peters (272), where the bar was high and the dredge was accordingly able to make a deep cut, in which the channel remained throughout the season. In the latter part of October the *Epsilon* and the *Zeta* were withdrawn from the field, as there was no work for them to do and it was believed that the other dredges would be able to handle any situation likely to arise so late in the season. The *Kappa* had been retired in September on account of the accident to her main engine, and during November the three remaining dredges, the *Delta*, the *Iota*, and the *Henry Flad*, were gradually retired, so that at the end of the month all the dredges were at the fleet, the *Delta* and the *Henry Flad* being kept in commission ready for use if needed.

Up to this time a channel of 10 feet or over had been maintained except at Peters, where 9½ feet was found at the beginning of the season. The river was then rising at Cairo and the season was considered closed, the general belief being that the rise then in progress was the beginning of the usual midwinter high water. About the 1st of December, however, the weather in the Ohio and Mississippi valleys turned suddenly cold, and an unexpected, rapid, and continuous fall set in on the 3d, the river dropping to a stage of 2.8 at Cairo on the 20th. An even more abrupt rise followed, reaching a stage of 9.7 on the 25th and 11.6 on the 29th. The corresponding stages at Memphis were 6 on December 4, 0.9 on the 23d, and 5.6 on the 31st. On December 9 the inspection party found a depth of 8½ feet at the foot of Island 21 (131), and the *Henry Flad* was at once ordered into the field, followed within a day or two by the *Delta* and the *Kappa*. The *Iota* was put in commission, but was not sent into the field on account of the shortage of coal.

At this time there remained on hand about 40,000 bushels of coal for dredging operations, or thirty-five days' supply for one dredge. Thirty-five thousand bushels more had been ordered from the coal company, but they were unable to make any deliveries until the 28th, on account of the suspension of navigation in the Ohio River by ice and low water. Twenty-two thousand bushels were secured at Memphis, but it proved impossible to obtain more, as none of the coal companies was able to bring any coal out of the Ohio, and no arrangements for handling coal from cars could be made. On the 13th the *Henry Flad*, on her way up the river, sank a full barge at Craighead Point (171) and lost nearly three days waiting for a new supply. On the evening of the 21st a boat, containing about 10,000 bushels, which had that morning been delivered to the *Kappa*, was sunk at Presidents Island (235) by the steamer *James Lee*, and the contents lost. The *Kappa* was then forced to retire from the field, leaving only the *Delta* and the *Henry Flad* in operation for the rest of the month.

Under these circumstances the operations of the dredges did not keep pace with the falling of the river, and the depths were reduced considerably below 9 feet on many of the bars. Plates 3 to 8 show the observed depths on all bars above Montezuma (312) on which less than 9 feet was found, platted in connection with the hydrographs of the nearest gauges. It is probable that there was less than 9 feet on some of the bars below Montezuma during this period, but no inspection below this point was made until the 29th, after the rise had set in. At that time there was not less than 11½ feet below Helena (306). These plates show that the depths were less than 9 feet for from six to sixteen days on the various bars between December 7 and 26, 9 feet and over being restored on all bars by the latter date. Between the 15th and 26th navigation above Cairo on both the Ohio and Mississippi rivers was entirely suspended by ice and low water, the larger type of steamers having been compelled to suspend operations as early as the 5th. On the 13th ice began running in the river below Cairo, and a gorge was formed at Columbus on the 16th, lasting two or three days. Except for this interruption, however, the regular packets and numerous tows of lumber and logs ran between Memphis and Cairo, and the packets below Memphis continued to run throughout the month. It is not known that any boat grounded in the channel during the low stage, though several ran on the bars outside of the channel limits.

The failure to maintain the prescribed depth on all bars is not believed to indicate any inherent weakness in the project for maintaining below Cairo a channel 9 feet in depth by means of dredging, which has proved in past seasons able to cope successfully with lower water than was met with this year. The sudden fall came when the season was considered closed, and the operations of the fleet were seriously hampered by the scarcity of coal, numerous accidents, severe storms, and freezing weather. Those dredges which it was possible to operate readily opened channels through the bars at which they worked, indicating that had it been possible to put more dredges in the field a channel of the required dimensions could have been quickly secured and maintained.

The results obtained at each bar where dredging was done are briefly discussed below. Plates 10 to 35 illustrate these results at the more important localities. The first plate of each series shows the total area afterwards dredged, but each subsequent plate of the series shows only the area dredged prior to that survey.

New Madrid (72). No plates.—Dredging was done at this point, about 2 miles below the town, between October 28 and November 3. The channel followed close under the bar on the convex shore, and the dredging was intended to cut through the reef at its lower end. Before the work was completed, however, it was found that the river had gone through the reef above the town, making an 18-foot channel, and work was consequently abandoned.

Darnells bar (81). No plate.—No dredging was required on this bar until about December 10, when the depth first fell below 9 feet. It was impossible to get a dredge to the spot before the 28th, by which time the river had risen and there was 11½ feet on the bar. A small amount of dredging was done on the 28th, but as the river continued to rise work was discontinued.

Bixbys Towhead (83). Plates 9 to 13.—The conditions here before any work was done are shown on plate 9. The dredging by the *Iota* in August, September, and October produced very little effect, the high stages prevailing during this time making it impossible to make a cut deep enough to have much training effect on the current. The conditions at the end of October are shown on plate 10. The upper part and the crest of the reef have both moved down, but the least depth is about the same as at the beginning of the season. Dredging was continued by the *Henry Flad* between October 28 and November 10. The results of this dredging are clearly shown on plates 11 and 12. The effects of the deeper cut possible at this time are apparent. As the river fell the crossing became a little more square, and a small amount of dredging was done, deepening and widening the lower end. The results are shown on plate 13. The channel remained in this position for the rest of the season.

Cherokee Crossing (*90*). No plate.—A small amount of dredging was done here at a high stage. The effect was slight, but the channel remained permanently in position during the season.

Joe Eckles bar (*92*). No plate.—The work at this point was chiefly designed to straighten out a rather crooked channel. Owing to the high stage prevailing, the effect of the dredging was not very marked. The channel, however, was well defined and remained in position throughout the season. A short reef was also cut through at the lower part of the bar, and the channel maintains its position well. In December the depth was reduced below 9 feet, but was restored by the rise before any dredging could be done. A few hours' work was done later, but as the depth required by the project had been restored, nothing of value was accomplished.

Hathaway (*103*). Plates 14 to 20.—The conditions before any dredging was done are shown in plate 14. Plate 15, six days later, shows in a marked manner the effect of the first dredging done. Plate 16 shows conditions one month later—a rise of 5 feet at Cairo having passed in the interval. The channel is seen to be still clearly defined and of ample depth. A small amount of dredging was done to widen and straighten this channel, the results of which are shown in plate 17. The passage of another rise left the channel a little lower down, but broad and deep, as shown in plate 18. Later in the season further dredging was done at this point, and still later a small cut was made at the end of the crossing, but the results were unsatisfactory, little or no improvement resulting, as shown by plates 19 and 20. The channel produced at this bar was, however, one of the most satisfactory of the season as to permanence and depth. Even in the lower water of December, there was never less than 9 feet on this crossing

Chute of Island 20 (*127*). Plates 21-22.—The conditions at this point before any dredging was done are shown on plate 21. Very little was accomplished by the early dredging here, owing to the high stage. Plate 22 shows conditions a month later. The channel was still through the cut, but it was not very clearly defined. In December further work was required at this point. The *Delta* began work on the 22d with 6½ feet over the bar, and by the 24th a good 12-foot channel was produced.

Foot of Island 21 (*131*). Plates 23-25.—The first dredging on this bar was done by the *Kappa* early in September, but work was suspended by the accident to her engine before anything had been accomplished. The conditions at the end of that month are shown on plate 23. Plate 24, ten days later, after dredging by the *Henry Flad*, shows a good, well-defined channel through the dredged cut. The channel remained in this position throughout the season. Plate 25 shows its condition at the middle of November, when a practicable channel of 13 feet still existed. During the low water of December, which was 8 feet lower than at the time of this survey, a least depth of 6½ feet was found. The work done by the *Henry Flad*, December 24-25, resulted in an increase of several feet, but as the river was then rising rapidly the practical value of the work was small.

Gold Dust (*158*). No plate.—The first work here was done early in October and resulted in the production of a channel 16 feet in depth, though not as sharply defined as is desirable. Depths on the crossing remained satisfactory until the low water of December, when depths as low as 6½ feet were found. The *Henry Flad* dredged here from December 21 to 23, and produced a good, wide, clearly marked channel 12 feet in depth.

Luxora (*161*) *and New Haven* (*162*). Plates 26-27.—The conditions at this locality in the early part of the season are shown on plate 26. Plate 27 shows the conditions one month after dredging. The best channel is shown to be somewhat above the location of the dredged cut, and the channel is also shown to be narrowing and shoaling below, where it returns to the right bank. Later in the season this channel closed, and the channel followed down the shore to New Haven all the way. During the low water of December the channel down the shore also shoaled and narrowed throughout its whole length, particularly at the head. The *Henry Flad* cut through the bar at the head December 18-20, and later widened out the channel below, but the work was not of much value.

Last Chance (*166*). No plate.—About the end of September some dredging was done here in deepening and widening the channel through a short reef. The channel remained permanent for the rest of the season.

Random Shot (*192*). No plate.—No trouble was experienced at this point until December, when the depths were reduced as low as 6½ feet. The *Delta* dredged here for two days, December 15–17, and obtained a 12-foot channel. The work on this bar, with that at Gold Dust (158) in December, furnish excellent examples of quick and successful dredging.

Memphis wharf (*230*). No plate.—The work here consisted in the removal of the lower end of the large sand bar obstructing the wharf front, which was successfully accomplished.

Presidents Island (*234–235*). Plates 28–30.—The conditions before any dredging was done are shown on plate 28, and the results of the first work on plate 29. This plate, eighteen days after dredging, shows the channel still following the dredged cut, but also shows the tendency of the river to follow the shore of the island and cross the reef lower down. Because of this tendency, and of the extremely difficult character of the material where the first work was done, the second dredging was done lower down. The results are shown in plate 30, which shows the improvement of the new channel and the deterioration of the old. The channel remained in the second location for the rest of the season. During the low water of December the depth was reduced to 7½ feet, and the *Kappa* dredged here until she was forced to retire to the fleet. She succeeded in making a narrow cut through the bar.

Peters Crossing (*272*). Plates 31–34.—The conditions at this bar late in August are shown on plate 31. It will be seen that a bar 4 feet and more above low water extended completely across the river, the least width between the low-water contours being nearly half a mile. The dredging here was done with a deep cut, and though the rate of advance was slow, the results were excellent, as shown in plate 32, where a broad, deep channel is shown, following the dredged cut. Plate 33 shows the conditions after the passage of a rise of about 4 feet. The channel remained in the dredged cut, and was still of ample dimensions, though it had shoaled a little at the lower end. The results of the second dredging are shown on plate 34. An excellent channel is shown, following the dredged cut, and this channel remained in excellent condition throughout the season. During the low water in December there was 8 feet above the cut, while in the cut itself the depths were 10 to 12 feet and over. The work on this bar is perhaps the most successful of the season.

Dredging was done this year at 15 different localities. New Madrid and Random Shot were new places this year. The other bars dredged have all given trouble in former years. The amount of material moved by the dredges is estimated under the same suppositions as heretofore, that the width of each cut is the width of the dredge's suction, that the depth is as determined by the soundings, and that the side slopes are 1 on 2½. The result of this calculation is 891,098 cubic yards. In 1902 the amount was 813,380; in 1901, 1,666,465; in 1900, 1,145,559, and in 1899, 1,612,223 cubic yards.

For additional details, attention is invited to the report of Assistant Engineer F. B. Maltby, Appendix 1 C.

TESTS OF DREDGES.

During the season of 1902 exhaustive tests were made of the boilers, engines, and pumps of all the dredges except the *Beta*, which was not available. A full account of these tests appears in the supplement to the report of the Chief of Engineers for 1903, pages 136 to 167. During the season of 1903 supplementary tests of the main pump of the *Zeta*, using runners with three and seven blades, were made. The results obtained are given in Table No. 9. The results previously obtained with the 5-bladed runner are also given for comparison. Complete tests of the boilers of the *Beta*, and of one of her main pumping units, were also made, and tests were also made of the *Iota's* main pump, the runner of which had been converted into one of the inclosed type. The results of these tests are given in Table No. 10.

For the details of these tests, attention is invited to report of Assistant Engineer F. B. Maltby, Appendix 1 D.

SURVEY FOR 14-FOOT WATERWAY, MISSISSIPPI RIVER, FROM THE MOUTH OF THE ILLINOIS RIVER TO ST. LOUIS, MO.

A full history of this survey up to the date of the last annual report is published in the supplement to the report of the Chief of Engineers for 1903, page 68. During the season of 1903 a party was put in the field to supplement the work of the previous year. The party, in charge of Assistant Engineer W. G. Comber, with the steamers *Patrol* and *Mars* and the quarterboat *Illinois*, began the field work just above the Merchants' Bridge, St. Louis, on September 24, and the work was closed for the season December 3. The work done by this party included levels and topography on the large islands omitted in 1902, and on the lowlands east of the river, from the Merchants' Bridge to Wood River; also topography of the Columbia Bottoms where not covered by previous surveys; topography and levels between the Mississippi and the Missouri rivers, in the vicinity of Portage, Mo.; soundings in the Missouri River for two miles up from the mouth; and the location of dikes in the river between Grafton and St. Louis. The discharges of the Illinois River, and of the Mississippi both above and below the mouth of the Illinois, were measured, and eight borings made in the river bed to rock, the boring apparatus being mounted on a pile driver. In drawing the pipe from the eighth boring the hoisting engine was disabled, and the boring operations were then suspended for the season.

The work of reducing and platting the field notes has been in progress since the close of the field work. The finished maps will cover 13 sheets, on a scale of 1:4,800.

The following papers accompany this report:

Summary.

Money statements.

Consolidated statement of appropriations and allotments.

Abstracts of contracts in force.

Commercial statistics.

Statement of charts issued and sold.

Appendix 1 A. Laws affecting the Mississippi River Commission, July 1, 1903, to June 30, 1904.

Appendix 1 B. Report of Assistant Engineer Kivas Tully on gauges, discharge observations, reduction of physical data, and office publications.

Appendix 1 C. Report of Assistant Engineer F. B. Maltby on dredging operations on the Mississippi River between Head of the Passes and mouth of the Ohio River, and care and repair of dredging plant.

Appendix 1 D. Report of Assistant Engineer F. B. Maltby on efficiency tests of hydraulic dredges.

Appendix I E. Specifications for new self-propelling hydraulic dredge *B. M. Harrod.*

Table No. 1. Highest and lowest gauge readings in 1903, Mississippi River and tributaries.

Table No. 2. Maximum readings on high water and regular gauges on the Mississippi River from Cairo to the Passes during the flood of 1904, with readings in 1903 for comparison.

Table No. 3. Highest gauge readings in 1904 (to June 30), at stations on the Mississippi River above Cairo and on tributaries of the Mississippi River.

Table No. 4. Results of discharge observations, Mississippi River and tributaries.

Table No. 5. Results of meter ratings.

Table No. 6. Summary of dredging operations, Mississippi River below Cairo during low-water season of 1903.

Table No. 7. Cost of dredging operations, April 1, 1903, to March 31, 1904.

Table No. 8. Depths over shoal crossings, Mississippi River, low-water season of 1903.

Table No. 9. Data and results of main pump tests of dredge *Zeta*, with three, five, and seven bladed runners.

Table No. 10. Data and results of main pump tests of dredge *Beta* and dredge *Iota* with shrouded runner.

Plate 1. Hydrograph of the Mississippi River, Cairo, Ill., to Fort Jackson, La., June 1, 1903, to May 31, 1904.

Plate 2. Profile of the Mississippi River, high water of 1904, from Cairo, Ill., to Head of Passes, La.

Plates 3 to 28. Dredge maps.

Plates 29 to 34. Least depths on bars, Cairo to Montezuma, low-water season of 1903.

Plate 35. Testing dredges, dredge *Beta*, main pump.

Respectfully submitted.

WM. B. LADUE,
Captain, Corps of Engineers,
Secretary Mississippi River Commission.

The PRESIDENT MISSISSIPPI RIVER COMMISSION.

SUMMARY TO ACCOMPANY ANNUAL REPORT OF CAPT. WM. B. LADUE, CORPS OF ENGINEERS, SECRETARY MISSISSIPPI RIVER COMMISSION.

Mississippi River Commission,
Office of the Secretary,
St. Louis, Mo., May 31, 1904.

The works in charge of the secretary of the Mississippi River Commission are carried on under allotments made by the Commission from appropriations for improving the Mississippi River between the Head of the Passes and the mouth of the Ohio River; under allotment for fiscal year from permanent appropriation provided by section 9 of the river and harbor act of June 13, 1902, for gauging the waters of the Mississippi River and its tributaries, and under appropriation in river and harbor act of June 13, 1902, for surveys and examinations from mouth of Illinois River to St. Louis to determine the feasibility of navigable waterway 14 feet in depth.

IMPROVING MISSISSIPPI RIVER.

The allotments from this appropriation are as follows:

(*1*) *Mississippi River Commission.*—Available for salaries, clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission.

(*2*) *Surveys, gauges, and observations.*—Available for survey of the Mississippi River between the Head of the Passes and its headwaters, for the establishment and maintenance of gauges, for special surveys and examinations, and for the collection and reduction of physical data pertaining to the Mississippi River.

(*3*) *Dredges and dredging.*—Available for the construction, operation, and maintenance of dredging plant for the Mississippi River from Head of the Passes to the mouth of the Ohio River.

The project adopted by act of Congress approved March 3, 1881, contemplated the systematic improvement of the Mississippi River from Cairo to the Head of the Passes, with a view of ultimately obtaining 10 feet depth in all channels at low water. The act of June 28, 1879, creating the Mississippi River Commission, prescribed as one of its duties "To direct and complete such surveys of said river between the Head of the Passes near its mouth to its headwaters as may now be in progress, and to make such additional surveys, examinations, and investigations, topographical, hydrographical, and hydrometrical, of said river and its tributaries as may be deemed necessary by said Commission to carry out the objects of this act." Prior to September 19, 1890, the expenses of the Mississippi River Commission and of the survey of the Mississippi River, etc., were paid from special appropriations. The total amount of these special appropriations expended under the secretary was $1,093,358.11, of which $238,110.74 was allotted to the Mississippi River Commission and $855,247.37 to surveys, etc. By the act of September 19, 1890, the project for improving Mississippi River was modified to include the salaries, clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission and surveys, including the survey from the Head of the Passes to the headwaters of the river. By the act of June 3, 1896, a modified project was adopted for the construction, maintenance, and operation of suitable dredge boats, with a view to ultimately obtaining and maintaining a navigable channel from Cairo down, not less than 250 feet in width and 9 feet in depth at all periods of the year except when navigation is closed by ice.

Previous to the adoption of the project by Congress, March 3, 1881, no work had been done, except the beginning of the survey of the Mississippi River and the making of observations for the collection of physical data. Prior to the organization of the Commission the following survey work on the lower Mississippi had been done:

Under the Coast and Geodetic Survey, between January, 1868, and June 30, 1879, the secondary triangulation was completed from the Head of the Passes, Louisiana, to Donaldsonville, La. (1060 to 885); from Natchez, Miss., to Grand Gulf, Miss. (700 to 636), and from Vicksburg, Miss., to Omega Landing, Louisiana, (599 to 578). Under the United States Lake Survey, between November, 1876, and June 30, 1879, the secondary triangulation of 15 miles near Cairo, Ill., and from near Memphis, Tenn., to Helena, Ark. (230 to 306), was completed. Precise levels had been run from Cairo, Ill., to Columbus, Ky. (21), and from Memphis, Tenn., to Friars Point, Miss. (230 to 319).

Under the Coast and Geodetic Survey, the topography and hydrography between the Head of the Passes and Donaldsonville, La. (1060 to 885), had been completed. Under the United States Lake Survey the topography and hydrography for about 15 miles near Cairo, and from the head of Frames Chute to Campbells Landing (225 to 272) had been completed.

Each department had published charts of its own work.

The total amount expended by the secretary, Mississippi River Commission, from the adoption of the approved project, September 19, 1890, to June 30, 1904, has been $4,351,569.99, of which $475,101.03 was spent for Mississippi River Commission, $923,292.27 for surveys, gauges, and observations, and $2,907,045.55 for dredges and dredging; also for experimental dikes $45,075.58, and for patrol of the Mississippi River, $1,055.56.

The appropriations and allotments for the Mississippi River Commission have been expended for salaries, traveling expenses, mileage, etc., of the Mississippi River Commission.

The appropriations and allotments for surveys, gauges, and observations have been expended in completing the secondary triangulation, precise levels, topography, and hydrography of the entire river from the mouth to Lake Itasca, a river distance of about 2,350 miles. Of this work there remains to be done only the topography and hydrography over about 30 miles of river near the headwaters. The precise levels have been run from the jetties to Fort Adams, Miss. (753 L), and side lines run from Carrollton, La., to Biloxi, Miss. (87 miles); from Savanna, Ill., to Chicago, Ill. (148 miles), and from St. Paul, Minn., to Duluth, Minn. (156 miles). Maps of the river have been prepared and published, and special surveys made at various localities for the determination of changes in bank lines and section and for the collection of physical data.

A list of the maps and charts issued by the Commission will be found in the supplement to the report of the Chief of Engineers for 1902, page 35.

A description of the methods used in the surveys of the river will be found in report of the Chief of Engineers for 1891, pages 3474–3485, and report for 1899, pages 3469–3474.

Nineteen permanent gauges have been established and maintained below St. Louis, Mo., on the Mississippi, its tributaries, and the Gulf of Mexico. One hundred and eighty-five high-water gauges have been established between Cairo, Ill., and Head of the Passes, Louisiana (1060).

Various discharge and other observations have been made from time to time under direction of the Commission.

Under the allotment for dredges and dredging, nine dredges, the *Alpha*, *Beta*, *Gamma*, *Delta*, *Epsilon*, *Zeta*, *Iota*, *Kappa*, and *Henry Flad*, have been turned over to the secretary for operation, together with the other necessary plant. One of these dredges, the *Alpha*, is now dismantled; the hull has been condemned and broken up, and the machinery transferred to other engineer districts.

During the season of 1895 the *Alpha* succeeded in maintaining a navigable channel between Cairo and Cherokee Crossing (90). During the low-water season of 1896 the *Alpha* and *Beta* were operated opening and maintaining channels across all bars between Cairo and Memphis (230 L). The season being unusually favorable, no difficulty whatever was experienced below Memphis (230 L). During subsequent seasons the available dredges were operated where required below Cairo, and navigable channels of the specified dimensions opened and maintained through all bars, excepting for a few days in December, 1903, when the depth fell below 9 feet.

The commerce of the Mississippi River consists chiefly of coal, lumber, logs, iron, steel, grain, cotton and cotton seed, provisions, and unclassified commodities. The total quantity of all classes carried on the different stretches of the river below Cairo in 1901, 1902, and 1903 are as follows:

	1901.	1902.	1903.
	Tons.	*Tons.*	*Tons.*
Between Cairo and Memphis	2,306,302	2,548,331	2,250,260
Between Memphis and Vicksburg	1,856,339	1,940,026	2,018,222
Between Vicksburg and New Orleans	1,835,174	2,159,258	2,207,692

Commercial statistics were not compiled prior to 1901.

GAUGING THE WATERS OF THE LOWER MISSISSIPPI RIVER AND ITS TRIBUTARIES.

By joint resolution of Congress, approved February 21, 1871, the Secretary of War was directed to have water gauges established and daily observations made on the lower Mississippi River and its chief tributaries at an annual cost of not to exceed $5,000. Under the provisions of this resolution gauges have been established and maintained at St. Louis, Mo., Cairo, Ill., Memphis, Tenn., Helena, Ark., mouth of White River, Ark., Lake Providence, La., Vicksburg, Miss., Natchez, Miss., Red

River Landing, La., Baton Rouge, La., Donaldsonville, La., and Carrollton, La., on the Mississippi; at Louisville, Ky., (2) on the Ohio; at Nashville, Tenn., on the Cumberland; at Florence, Ala., on the Tennessee; at Jacksonport, Ark., on the White; at Little Rock, Ark., on the Arkansas; and at Fulton, Ark., Shreveport, La., and Alexandria, La., on the Red—a total of 21.

By the act of August 11, 1888, a permanent indefinite appropriation of $6,000 annually was established for the maintenance of these gauges, which sum was increased by the act of June 13, 1902, to $9,600. These gauges were transferred to the Mississippi River Commission, February 11, 1901, by order of the Secretary of War, and since that date have been maintained by the secretary of the Commission.

The amount expended on the approved project, to the end of the fiscal year 1904, is $162,256.37.

SURVEYS AND EXAMINATIONS OF THE MISSISSIPPI RIVER FROM THE MOUTH OF THE ILLINOIS RIVER TO ST. LOUIS, MO., IN CONNECTION WITH THE PLANS FOR A NAVIGABLE WATERWAY 14 FEET DEEP, FROM LOCKPORT, ILL., TO ST. LOUIS, MO.

By act of June 13, 1902, the Mississippi River Commission was charged with the duty of making the required surveys and examinations, $25,000 being allotted for the purpose.

Under this appropriation a topographic and hydrographic survey of the river from the mouth of the Illinois River to St. Louis has been completed, discharge observed, and borings made. The results of these surveys have been combined with data obtained from other sources, and platted. For full account of the surveys up to June 30, 1903, see supplement to report of the Chief of Engineers for 1903, page 68.

The total expenditure up to June 30, 1904, has been $15,846.45.

Money statement.

[Appropriation for improving Mississippi River.]

July 1, 1903, balance unexpended		[a]$249,822.43
Amount allotted from appropriation by sundry civil act approved March 3, 1903	$328,000.00	
Miscellaneous receipt in settlement of claim against the Southern Pacific tug *El Valle* for damages to dredge *Beta* in August, 1903, collected by the United States attorney for the eastern district of Louisiana. Credited to allotment for "Dredges and dredging"	159.00	
		328,159.00
		577,981.43
June 30, 1904, amount expended during fiscal year		376,892.65
July 1, 1904, balance unexpended		201,088.78
July 1, 1904, outstanding liabilities	$31,916.97	
July 1, 1904, amount covered by uncompleted contracts	69,276.08	
		101,193.05
July 1, 1904, balance available		99,895.73

[Appropriation for gauging the waters of the lower Mississippi and its tributaries.[b]]

July 1, 1903, balance unexpended	$1,541.36
Amount allotted by Chief of Engineers, April 18, 1903, from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, as amended by section 9 of river and harbor act of June 13, 1902	9,100.00
	10,641.36

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[a] Amount, $249,810.93, reported in Annual Report for 1903, increased $11.50 reclamation on check No. 148777 on assistant treasurer, St. Louis, Mo., on account of forged indorsement, deposited to credit of Treasurer of United States in June, 1901.

[b] The custody and care of the gauges maintained under this appropriation were assumed by the Mississippi River Commission February 11, 1901, on which date they were transferred to the secretary, under authority of Secretary of War, dated January 25, 1901.

June 30, 1904, amount expended during fiscal year	$6,987.94	
June 30, 1904, amount reverted to Treasury during fiscal year	887.34	
		$7,875.28
July 1, 1904, balance unexpended		2,766.08
July 1, 1904, outstanding liabilities		2,300.75
July 1, 1904, balance reverting to Treasury		465.33
Amount that can be profitably expended in fiscal year ending June 30, 1906, in addition to the balance unexpended July 1, 1904		9,100.00

Itemized statement of expenditures during the fiscal year ending June 30, 1904, submitted in compliance with requirement of section 6 of river and harbor act of August 11, 1888.

Observations:		
Pay of permanent gauge observers		$2,745.83
Inspections and repairs:		
Inspection of gauges on Mississippi River by junior engineers and party on steamer	$1,245.18	
Inspection of gauges on tributaries	272.39	
Renewals and repairs of gauges and bulletins	1,854.52	
		3,372.09
Office expenses and contingencies:		
Pay of assistant and junior engineers and recorders	779.32	
Stationery, printing, etc	90.70	
		870.02
		6,987.94

[Appropriation for waterway from Lockport, Ill., to St. Louis, Mo.]

July 1, 1903, balance unexpended	$17,527.52
June 30, 1904, amount expended during fiscal year	8,373.97
July 1, 1904, balance unexpended	9,153.55
July 1, 1904, outstanding liabilities	1,675.24
July 1, 1904, balance available	7,478.31

Consolidated statement of appropriations and allotments.

[Appropriation for gauging the waters of the lower Mississippi and its tributaries.]

Allotments from general appropriations for examinations, surveys, and contingencies of rivers and harbors by acts of—	
March 3, 1871	$5,000.00
June 10, 1872	5,000.00
March 3, 1873	5,000.00
June 23, 1874	5,000.00
March 3, 1875	5,000.00
Specific appropriations by river and harbor acts of—	
August 14, 1876	5,000.00
June 18, 1878	5,000.00
March 3, 1879	5,000.00
June 14, 1880	5,000.00
March 3, 1881	5,000.00
August 2, 1882	5,000.00
Deficiency act of March 12, 1884	2,100.00
Specific appropriations by river and harbor acts of—	
July 5, 1884	5,000.00
August 5, 1886	5,000.00

Allotted from specific appropriation by river and harbor act of August 11, 1888	$8,700.00
Deficiency act of October 19, 1888	3,600.00
Allotments from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, for fiscal years, viz:	
1890	9,000.00
1891 (less $3,518.34 withheld in United States Treasury under ruling that only $6,000 can be expended each fiscal year)	5,181.66
1892	5,100.00
1893	5,500.00
1894	5,500.00
1895	5,500.00
1896	5,500.00
1897	5,500.00
1898	5,500.00
1899	6,000.00
1900	5,500.00
1901	6,000.00
1902	6,000.00
Allotments from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, as amended by section 9 of river and harbor act of June 13, 1902, for fiscal years, viz:	
1903	9,100.00
1904	9,100.00
Total	173,381.66

EXPENDED.

	To June 30, 1903.	During year ending June 30, 1904.	Total.
Expenditures	$155,268.43	$6,987.94	$162,256.37
Unexpended balances reverted to Treasury	8,359.21		8,359.21
Total	163,627.64	6,987.94	170,615.58
Unexpended balance June 30, 1904			2,766.08
Total appropriated, etc			173,381.66

[Appropriation for waterway from Lockport, Ill., to St. Louis, Mo.]

Act of June 13, 1902 (river and harbor)	$25,000.00

EXPENDED.

	To June 30, 1903.	During year ending June 30, 1904.	Total.
Expenditures	$7,472.48	$8,373.97	$15,846.45
Unexpended balance June 30, 1904			9,153.55
Total appropriated, etc			25,000.00

Abstract of contracts entered into by Capt. Wm. B. Ladue, Corps of Engineers, in force June 30, 1904.—Improving Mississippi River, Mississippi River Commission, secretary's office.

Contract for—	Contractor.	Rate.	Date of contract.	Date of approval.	Date of beginning work.	Date of expiration.
			1903.		1904.	1904.
Furnishing 5 two-horse teams.	Martin Heinzelman.	$99 per month each team.	Dec. 23	(a)	Jan. 10	(b)
			1904.	1904.		
Rebuilding hull of U. S. S. Minnetonka.	Ed. J. Howard......	Various unit rates; estimated cost of work, $15,000.	Apr. 29	May 21	June 1	Aug. 27
Rebuilding hull of U. S. S. Patrol.	.....do..............	Various unit rates; estimated cost of work, $6,800.	May 4	(a)	....do...	July 30
						1905.
Furnishing 350,000 bushels coal.	The Monongahela River Consolidated Coal and Coke Co.	13 cents per bushel..	May 14	June 7	June 7	July 31

[a] Emergency contract.

[b] About July 31.

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1903.

TABLE No. 1.—*Passenger and tonnage traffic between principal ports.*

Between—	Number of passengers.	Receipts and shipments, in tons.					
		Grain and its products.	Cotton.	Cotton seed.	Live stock.	Coal and coke.	Lumber.
St. Louis and Cairo..........	87,458	103,114	585	340	18,010	119,727	120,231
Cairo and Memphis..........	56,621	100,222	10,065	10,850	15,040	1,266,378	209,541
Memphis and Vicksburg.....	101,797	114,974	31,695	145,988	4,830	1,281,311	80,026
Vicksburg and New Orleans.	87,189	125,236	39,519	53,909	7,337	1,263,372	80,500

Between—	Receipts and shipments, in tons.						
	Logs.	Iron, steel, and metals.	Groceries and provisions.	Railroad cross-ties.	Gravel, sand, and stone.	Miscellaneous and unclassified.	Total.
St. Louis and Cairo..........	89,662	82,797	35,485	18,243	....	60,987	649,181
Cairo and Memphis..........	430,530	77,331	4,836	5,397	13,000	107,070	2,250,260
Memphis and Vicksburg.....	236,521	44,369	31,191	3,131	10,000	34,186	2,018,222
Vicksburg and New Orleans.	212,375	52,891	157,540	....	27,983	[a] 187,030	2,207,692

[a] Includes 122,061 tons of oil.

NOTE.—Each stretch is treated as a separate river, and tonnage carried between ports on different stretches will appear in the statistics of all intervening stretches. Consequently the sum of the tonnage carried in the four stretches does not represent the total traffic on the river as a whole.

TABLE No. 2.—*Receipts and shipments at principal ports.*

Ports.	Passengers carried in and out of port.	Receipts and shipments, in tons.					
		Grain and its products.	Cotton.	Cotton seed and its products.	Live stock.	Coal and coke.	Lumber.
St. Louis, Mo..................	80,380	111,806	653	348	29,254	119,746	[a] 132,659
Memphis, Tenn..............	84,624	7,440	21,458	22,262	1,903	108,074	18,296
Vicksburg, Miss. [b]............	16,658	27,092	9,408	134,803	2,045	66,049	14,142
New Orleans, La. [c]...........	40,169	856,874	619,915	292,642	6,985	1,217,878	397,587

[a] Includes 10,654 tons of railroad cross-ties.

[b] The traffic on the Yazoo River and its tributaries not included.

[c] Includes exports and imports and the domestic coastwise traffic, as far as reported.

TABLE No. 2.—*Receipts and shipments at principal ports*—Continued.

Ports.	Receipts and shipments, in tons.					
	Logs.	Iron, steel, and metals.	Groceries and provisions.	Gravel, sand, and stone.	Miscellaneous and unclassified.	Total.
St. Louis, Mo	55, 677	4, 112	49, 059		95, 562	598, 876
Memphis, Tenn	221, 058	35, 625	8, 467		61, 069	500, 652
Vicksburg, Miss. [a]	123, 000	1, 954	15, 601	2, 000	17, 884	413, 978
New Orleans, La. [b]	166, 725	78, 071	763, 185	24, 383	[c] 958, 368	5, 382, 583

[a] The traffic on the Yazoo River and its tributaries not included.
[b] Includes exports and imports and the domestic coastwise traffic, as far as reported.
[c] Includes 349,837 tons of oil.

TABLE No. 3.—*Seagoing traffic at New Orleans, La.*

Arrivals and departures:	
Number	2, 676
Tonnage	4, 759, 097
Receipts and shipments:	
Grain and its products	650, 112
Cotton	571, 622
Cotton seed and its products	320, 895
Live stock	18, 579
Lumber	178, 890
Iron, steel, and metals	158, 913
Groceries and provisions	388, 201
Miscellaneous and unclassified	810, 588
Total	3, 097, 800

TABLE No. 4.—*Ferry traffic.*

Location of ferries and transfers.	Number of passengers.	Receipts and shipments, in tons.					
		Grain and its products.	Cotton.	Cotton-seed and its products.	Live stock.	Coal and coke.	Lumber.
St. Louis, Mo	1, 569, 480				23, 892	541, 631	304, 000
Chester, Ill.; Cape Girardeau, Mo.; Grays Point, Mo., to Thebes and Gale, Ill	39, 844	32, 999	24, 789	1, 563	11, 430	89, 149	541, 302
Cairo, Ill.; Belmont, Mo., to Columbus, Ky	82, 899	19, 796	479	338	2, 901	4, 972	175, 700
Memphis, Tenn	115, 000	77, 400	16, 128	3, 705	3, 810	13, 325	47, 250
Helena, Ark.; Arkansas City, Ark	12, 381	6, 000	625	3, 000	1, 025		12, 000
Vicksburg, Miss	66, 535	9, 808	213	516	2, 110	50, 122	6, 843
Natchez, Miss.; Bayou Sara, La.; Baton Rouge, La.; Donaldsonville, La	133, 751	9, 828	787	1, 340	2, 915	720	1, 354
New Orleans, La	1, 873, 024	116, 139	131, 513	80, 242	42, 535	221, 164	172, 990

Location of ferries and transfers.	Receipts and shipments, in tons.					
	Logs.	Iron, steel, and metals.	Groceries and provisions.	Sand, gravel, and stone.	Unclassified and miscellaneous.	Total.
St. Louis, Mo		25, 000		1, 162, 500	5, 235, 665	7, 292, 688
Chester, Ill.; Cape Girardeau, Mo.; Grays Point, Mo., to Thebes and Gale, Ill	6, 517	97, 264	19, 618		186, 715	1, 051, 190
Cairo, Ill.; Belmont, Mo., to Columbus, Ky	25, 626	4, 637	6, 695		404, 721	645, 865
Memphis, Tenn	5, 700	43, 605	72, 155	40, 000	34, 692	357, 770
Helena, Ark.; Arkansas City, Ark	50, 000		8, 000		2, 000	82, 650
Vicksburg, Miss		30, 084	1, 636		376, 003	477, 835
Natchez, Miss.; Bayou Sara, La.; Baton Rouge, La.; Donaldsonville, La	10, 000	150	1, 600		61, 561	90, 255
New Orleans, La		109, 940			1, 490, 274	2, 364, 797

Statement of maps and charts issued and sold from July 1, 1903, to June 30, 1904.

Description.	Free.	Sold.	Total.
Upper alluvial valley map	148	21	169
Lower alluvial valley map	432	162	594
Inch-to-mile map	2,002	1,466	3,468
Detail chart, 1: 20000 scale	2,139	576	2,715
Detail chart, 1: 10000 scale	1,187	....	1,187
Detail chart, 1: 10000 scale (Harbor of New Orleans)	25	32	57
District map of lower Mississippi River	8	3	6
Lake Itasca Basin	215	11	226
St. Francis Basin	44	73	117
Total	6,145	2,344	8,489

Proceeds deposited with the assistant treasurer of the United States, at St. Louis, Mo., $307.11.

APPENDIX 1 A.

LAWS AFFECTING THE MISSISSIPPI RIVER COMMISSION, JULY 1, 1903, TO JUNE 30, 1904.

[PUBLIC—No. 193.]

AN ACT Providing for the restoration or maintenance of channels, or of river and harbor improvements, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in view of the fact that no general river and harbor bill is to be enacted during the present session, and in view of the necessity of temporary provision for the preservation of existing work, the sum of three million dollars be, and the same is hereby, appropriated, to be paid out of any money in the Treasury not otherwise appropriated, to be immediately available and to be expended under the direction of the Secretary of War and the supervision of the Chief of Engineers, for the following purposes and under the limitations herein set forth, to wit: For the restoration or maintenance of channels, or of river and harbor improvements, established or made by the Government, where the usual depth of such channels or customary use of such improvement has become, or may be, impaired and there is no sufficient fund available for such restoration or maintenance, with a view to preserve in their normal condition of efficiency existing channels and improvements: *Provided,* That allotments from the amount herein named shall be made by the Secretary of War, and no such allotment shall be made unless the necessity for such restoration or maintenance shall have arisen since the passage of the river and harbor Act of June thirteenth, nineteen hundred and two, and the same shall be recommended by the local engineer having such channel or improvement in charge and the Chief of Engineers, respectively: *Provided further,* That no single channel or improvement shall be allotted a sum greater than fifty thousand dollars, nor any portion of the said appropriation, unless the same is necessary in the interest of navigation or to protect and preserve any existing Government work in the interest of navigation.

SEC. 2. That in all cases in which appropriations or authorizations have heretofore been made for the completion of river and harbor works the Secretary of War may, in his discretion, on the recommendation of the Chief of Engineers, apply such amounts as have been appropriated or authorized for the prosecution of such work.

SEC. 3. That in order to repair the damage caused by the flood of nineteen hundred and three, and to restore and continue the improvement in the levee system of the Mississippi River interrupted by that flood, the Secretary of War may, as recommended by the Mississippi River Commission, enter into contract or contracts for levee work upon the Mississippi River between Cairo and the Head of the Passes during the fiscal year ending June thirtieth, nineteen hundred and five, to the extent of one million dollars, to be paid for out of the appropriation for that stretch of the river, authorized by the river and harbor Act of nineteen hundred and two, for the fiscal year ending June thirtieth, nineteen hundred and six, when the appropriation for the last-named fiscal year shall become available.

* * * * * * *

Approved, April 28, 1904.

[PUBLIC—No. 194.]

AN ACT Making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, nineteen hundred and five, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, for the objects hereinafter expressed, for the fiscal year ending June thirtieth, nineteen hundred and five, namely:

* * * * * * *

UNDER THE WAR DEPARTMENT.

* * * * * * *

UNDER THE MISSISSIPPI RIVER COMMISSION.

Improving Mississippi River: For continuing improvement of Mississippi River from Head of Passes to the mouth of the Ohio River, including salaries and clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission, two million dollars.

* * * * * * *

Approved, April 28, 1904.

APPENDIX 1 B.

REPORT OF MR. KIVAS TULLY, ASSISTANT ENGINEER, ON GAUGES, REDUCTION OF PHYSICAL DATA, AND OFFICE PUBLICATIONS.

ST. LOUIS, MO., *May 31, 1904.*

CAPTAIN: I have the honor to submit the following report upon the work pertaining to gauges, discharge observations, and office publications from June 1, 1903, to May 31, 1904:

GAUGES.

A detailed description of all gauges in charge of this office may be found in supplement to Report of Chief of Engineers for 1902, pages 52 to 59. No changes have since been made in number or location of these gauges, but the St. Louis and Cairo gauges were reconstructed in 1902 of steel-concrete, the Belmont, Mo., gauge was moved across the river to Columbus, Ky., and some other renewals made as described in supplement to Report of Chief of Engineers for 1903, pages 98 to 101. The Memphis gauge also was reconstructed of concrete-steel during the present year.

All the gauges were inspected during the low-water period; the high-water inspection is now nearing completion.

The low-water inspection from St. Louis to Memphis was made by a party on the small tender *Mars* with the quarter boat *Illinois* in December, at about the extreme low water of the year. From Memphis to Fort Jackson the low-water inspections were made in November to February by a party on the steamer *Patrol,* in connection with other survey work and partly at time of lowest water. At Helena, Sunflower Landing, Arkansas City, Greenville, Lake Providence, Vicksburg, St. Joseph, Natchez, and Red River Landing the lowest sections used this year were under water at time of inspection.

Special inspections were made of the gauges at Mhoon Landing and mouth of White River, where unstable banks caused large settlements in the lower sections. With the exception of these two stations, the errors found by levels at inspections were mainly less than 0.2 foot, and the corrections for these errors have been well determined. The following stations comprise those where work was done on new gauges or where any material disturbance of gauge sections occurred:

St. Louis, Mo. (U. S. engineer gauge).—The new steel gauge was tested by duplicate leveling in August and December, 1903, and found practically correct. The graduations were therefore cut in the steel face of the inclined gauge from 5 to 31.4 feet. The graduations are to each tenth of a foot, cut in with a diamond-pointed chisel, the numbers being cut in with the same chisel at each foot mark in figures about 3 inches high.

The vertical section on the west face of west steel pillar, on south line of Market street, of the elevated terminal railway was repainted in August, 1903. The graduations extending from 34 to 41.5 feet were carefully reproduced. The extreme high water of 1903, which reads exactly 38 feet, is marked on this section by a horizontal line about 2 inches long, cut with a chisel in face of the steel web plate. This is the highest water here since 1844.

The highest reading of 1904 occurred on April 29, and read 33.6 feet on vertical steel section attached to the south face of the city harbor office on the levee.

Readings below 5 feet were taken on temporary posts set out as the river fell. These were tested frequently by level connection with the permanent marks, and the readings have been corrected to agree precisely therewith. It is the intention to construct a permanent low-water section during the coming year if the stage permits.

Memphis, Tenn. (U. S. engineer gauge).—The old gauge near the foot of Beal street was in vertical sections; parts being attached to railway incline; it was maintained with difficulty. A new gauge was constructed on the levee in line with Beal street. This is of the concrete-steel type similar to that at St. Louis, except that in place of wooden piles concrete piers are used in compliance with local wharf regulations. The gauge follows the slope of the paved levee and is about 258 feet long, extending from about the 4-foot mark to 41 feet. Temporary marks have been made in the concrete from 21 to 41 feet; the marks will be cut in the steel when the gauge has been sufficiently tested. The construction work was done under contract and completed in January, 1904. It is the intention to extend the gauge to extreme low water when the stage of river permits.

Mhoon Landing, Miss. (Mississippi River Commission gauge).—This gauge was inspected October 19, 1903, and the gauge section in use found to be 0.54 foot too low; other sections were also in error. These errors had probably begun early in July; the records were corrected by coordinate plats of Helena and Memphis. At the regular inspection, November 4, the gauge in use was 0.07 foot low. On December 30 another inspection was made, as the office hydrographs indicated an error. The section in use was found to be 0.91 foot too low; errors in readings had also been made by the observer. This section had been set by the observer about November 23 and the proper corrections have been made of the records. The gauge evidently was again disturbed about January 12, 1904, when the stage got below 3 feet, but before an inspection could be made the river rose rapidly and has not since reached the low sections. The records from January 12 to 22, inclusive, have been corrected by coordinate plats.

Mouth of White River, Ark. (U. S. engineer gauge).—The gauge at this station is in vertical sections; the upper sections are attached to trees and are quite stable; the sections below 31.5 feet are nailed to heavy wooden posts which are driven down into the bank, and during the past low water the sliding of this bank has caused serious disturbance of the lower sections. At the regular inspection, November 7, 1903, the section in use was found to be 0.88 foot too low and was reset correctly; the sections were probably in error from early in August and the records were corrected on this assumption. Another disturbance occurred early in December, the error amounting to 3.8 feet when a special inspection was made January 23, 1904. The correction to the records for this period was derived from coordinate plats of Sunflower Landing and Arkansas City gauges.

Alexandria, La. (U. S. engineer gauge).—The error made in the graduations of this gauge, as stated in last year's report, was rectified at the inspection of October 15, 1903. The graduations were repainted correctly, reading from 4 feet to 40 feet. The graduations from 4 to 40 feet are painted on the steel web plate of the new bridge across Red River at foot of Murray street, Alexandria, La. The readings prior to October 15 were 0.2 foot too large and have been corrected.

Jacksonport, Ark. (U. S. engineer gauge).—Two sections of this gauge, reading from 10.5 to 34 feet, were moved to a new location by the railroad company in February, 1904, by permission of the secretary. These are now being inspected.

Clarendon, Ark. (Mississippi River Commission gauge).—The timber work of bridge to which the lower sections of this gauge were attached has been taken down, and temporary sections from 3 to 19 feet were set October 9, 1903. The bridge work is now completed and the sections are being put in their former positions. The bulletins at the regular gauge stations, on which are displayed the stage of the river to passing boats, were repaired and repainted where necessary by the gauge inspection parties. Many of these have been in service a long time and are nearly worn out. These are being replaced as rapidly as possible with the new type of steel bulletin introduced in 1902; three of these were put up during the year, one at each of the following stations: Vicksburg, Miss., Red River Landing and Donaldsonville, La. These have display plates 30 by 36 inches. Five more of these are now being made under contract; these are of the latest type, as shown on plate 3, Supplement to Report Chief of Engineers for 1903. The only change made is that the brass collars on which the plate frames revolve are increased from one-quarter inch to one-half inch in thickness

The highest and lowest readings in 1903 of all the gauges on the Mississippi River and its principal tributaries, with elevations and distances from Cairo, are given in Table No. 1. The daily readings of these gauges were platted on the office hydrographs in four sheets and traced for blueprinting. The hydrograph for stations on the Mississippi River below Cairo is given on plate No. 2.

The high-water gauges, located about 5 miles apart from Cairo to the Head of the Passes, were leveled to and put in good order by the regular gauge inspection parties previous to the high water; unusually complete postal-card reports have been received from the special observers of these gauges this year, but some shortages exist and these are being filled out and reported readings verified, from Head of the Passes to near Palmyra Island, by the party on the steamer *Vulcan*, and from Palmyra Island to Cairo by the party on the steamer *Mars*. The tabulated readings of these gauges will be found on Table No. 2, and the platted profile on plate No. 3.

The tide gauges at Biloxi, Miss., and East Bay, La., have been maintained during the year. The staff gauges and their bench marks were connected by precise leveling in January, 1904, and necessary repairs made to gauge house and plank approach at East Bay. The reduction of the records is in progress.

DISCHARGE OBSERVATIONS.

The low-water discharge observations were confined to those on the Tennessee and Cumberland rivers and some in connection with the waterway survey near Grafton, Ill. The Mississippi River reached the prescribed low stage for discharge work at two stations below Cairo, at Columbus, Ky. (21), December 20, and at Carrollton, La. (957), December 27; but owing to the severe weather and running ice in the river at Columbus, and the fact that the boats' crews were all engaged in other survey or dredging work, it was impracticable to organize discharge parties for either of these stations.

The Tennessee River reached the prescribed stage for low-water discharge observations early in September, and a small party was organized. Observations were made at the section laid out in 1902, 1½ miles below Birmingham, Ky., about 26 miles above the mouth. The party was in charge of Junior Engineer M. A. Bell, assisted by Mr. E. E. Whitehead, and a very complete set of measurements was made from September 5 to 19, comprising observations with Price and Haskell meters and double floats. The gauge readings at Florence, Ala., ranged from zero to —0.2 foot. The work was done from a skiff located by means of transit and stadia. The results are given in Table No. 4. The different methods, in the main, agree very closely. At the conclusion of work at this station the Cumberland River was approaching the prescribed low stage, and the party and outfit were transported by wagon across country to that river and began work September 21 at the section used at high water of 1902, which is 1 mile below Rock Castle, Ky., about 53 miles above the mouth. Sixteen sets of observations were made by October 2. The meters were then rated in the river and the party returned to the St. Louis office. The velocity of the river was very low, and as a check on the meter work floats were used, both double floats and rod floats; the double floats give somewhat larger discharges than the meters, but the discrepancies are not large. The gauge at Nashville, Tenn., during the observations ranged from 1.2 feet to 0.9 foot. The results are given in Table No. 4. It is thought that these measurements sufficiently determine the low-water discharge, and it was decided by resolution of the Commission that no more observations on these rivers at low water will be required.

The discharges of the Mississippi and Illinois rivers near Grafton, Ill., were measured in connection with the waterway survey, Assistant Engineer W. G. Comber, chief of party, with Mr. Bell in charge of meter work. A meter derrick and blocks were rigged up on the small tender *Mars* in November, with the intention of making observations with 5 meters in the same vertical simultaneously, using the electric chronograph and break-circuit chronometer. One set of observations by this method was made in the Illinois River about 1½ miles above its mouth, with satisfactory results; but as the steamer was required for other work observations were continued with only 2 meters, as the work had to be done from a skiff. On November 24 the work was closed, as heavy running ice was expected and it was necessary to get the plant into winter quarters on the lower river. The discharge of the Mississippi River was measured twice at Island 521 and at the former high-water section below the mouth of the Illinois River; also the discharge of the Illinois River was measured three times in all. The soundings and velocity stations were located by transit and stadia. The presence of the dike in the Mississippi River at the lower section affected the flow and the conditions were unfavorable for reliable measurements. The results are given in Table No. 4.

During the recent high water on the Mississippi River the discharges were measured at the maximum stage at all the regular discharge stations, as follows: Columbus, Ky. (21), April 3 to 7, four by meter and two by floats; Helena, Ark. (306), April 6 to 15, six by meter and two by floats; Chicot City, Ark. (432), April 11 to 21, ten by meter and two by floats; Vicksburg, Miss. (600), April 23, one by meter; Red River Landing, La. (765), April 29 to May 10, three by meter, also the Atchafalaya River at Simmesport, La., April 26 to 28, four by meter and two by floats; Carrollton, La. (957), April 23 to May 3, nine by meter and one by floats.

The observations at Helena and Carrollton were made by a party on the steamer *Vulcan* in charge of Junior Engineer M. A. Bell; all the others were made by a party on the steamer *Mars* in charge of Junior Engineer E. L. Harman.

The discharge of the Mississippi River at Thebes, Ill., 44.5 miles above Cairo, was measured by a party in charge of Assistant Engineer Wm. Gerig, on a small steamboat borrowed from the engineer officer in charge of the district. Eight discharges were measured by meter from April 29 to May 6. The results of these observations have not yet been computed.

Rating of current meters.—All the meters were rated at the settling basins of the city water works near Bissells Point, St. Louis, in August, 1903. These were rated from a skiff drawn over a 200-foot course at varying speeds; for the higher speeds a team of horses was used. Four meters were rated simultaneously by means of the electric chronograph and break-circuit chronometer before referred to. The results were quite satisfactory and the records of the chronograph rolls very perfect. All the rating observations were reduced by method of least squares and the results tabulated.

All the meters used during the high water were also rated in the field at conclusion of the discharge work by the parties using them. The results of these have not yet been reduced.

MISCELLANEOUS.

The daily stages of the Mississippi River and its principal tributaries for 1903 have been prepared and are being printed in the usual pamphlet form; this will comprise about 130 pages; some additional stations were printed this year at the request of the committee on gauges. The daily readings of gauges at stations on the main river and tributaries were sent out monthly in blueprint.

The proceedings of the Commission at the eighty-ninth, ninetieth, and ninety-first sessions, and the monthly reports of operations of the secretary and district officers, have been printed. The scientific records and drawings of the secretary's office have been cared for and the catalogues and card indexes kept up. Various information and data concerning the Mississippi River have been supplied on request.

I beg to acknowledge the valuable assistance of Messrs. E. J. Thomas, junior engineer, and E. E. Whitehead, recorder, who have been engaged in the computations and other office work while not in the field. Messrs. F. C. Hall and W. M. Garrott, recorders, also assisted in the office work, mainly copying gauge records and filing maps, and have shown faithfulness and diligence in their work.

Respectfully submitted.

Kivas Tully,
Assistant Engineer.

Capt. Wm. B. Ladue,
Corps of Engineers U. S. Army,
Secretary Mississippi River Commission.

TABLE No. 1.—*Highest and lowest gauge readings of 1908.*

MISSISSIPPI RIVER

Station	Distance from Cairo	Elevation of gauge zero above Cairo datum plane	Elevation of gauge zero above mean Gulf level	Highest.					Lowest				
				Prior to 1908		1908.		Difference compared with previous highest	Prior to 1908		1908.		Difference compared with previous lowest.
				Date	Gauge reading	Date.	Gauge reading		Date	Gauge reading.	Date.	Gauge reading.	
	Miles above.	*Feet*	*Feet.*		*Feet*		*Feet*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Aitkin, Minn	1,056.0	1,206.76	....	1899.	15.30	Oct. 14, 15	13.05	2.25	July 29, 1902	1.30	June 25	1.60	+0.30
St. Paul, Minn	858.0	704.57	....	Apr. 29, 1881	19.70	Oct. 14	13.50	6.20	Aug. 6, 1894; Mar. 21, 1895.	.20	Jan. 30	2.50	+2.30
Hastings, Minn	850.0	680.79	....	Apr. 30, 1881	18.00	Oct. 12-14	13.80	4.20	Nov. 23, 1892	.70	Feb. 16-23	1.50	+2.20
Winona, Minn	760.0	640.34	....	June 18, 1880	16.87	Sept. 19, 20	14.60	2.27	Dec. 30, 1889	-1.33	Feb. 19	2.30	+3.63
Prairie du Chien, Wis	668.0	625.59	....	June 22, 1880	21.30	Sept. 25	16.70	-4.60	Nov. 26, 1895	.10	Nov. 26	3.70	+3.60
Rock Island, Ill	510.7	562.37	....	June 27, 1892	19.40	Oct. 1	13.65	5.75	Jan. 5, 6, 1890	-.90	Dec. 2	2.00	+2.90
Burlington, Iowa	427.6	531.25	....	May 18, 19, 1888, June 30, 1892.	17.60	June 5, 6	14.90	2.70	Dec. 4, 5, 1895	1.10	Dec. 6	1.80	+2.90
Nashville, Iowa	388.6	516.86	....	May 17, 18, 1888	12.00	June 6	10.55	1.45	Jan. 7, 1890	.50	Dec. 14	.80	+1.30
Hannibal, Mo	329.4	469.60	....	May 17, 1888	21.58	June 8	22.50	+ .92	Jan. 9, 1890	1.75	Dec. 14, 15	.50	+2.25
Grafton, Ill	233.0	424.09	....	May 18, 1892	25.73	June 11	28.70	+2.97	Dec. 9, 1895	.90	Dec. 16	2.50	+3.40
St. Louis, Mo	190.8	400.23	....	May 19, 1892	a 35.94	June 10	38.00	+2.06	Jan. 2, 1900	2.52	Dec. 18	.55	+3.07
Chester, Ill	115.5	361.30	....	May 21, 1892	31.20	June 13, 14	33.30	+2.10	Jan. 3, 1900	4.10	do	1.40	+5.50
Cape Girardeau, Mo	54.5	320.97	....	Apr. 12, 13, 1897	31.60	June 14	36.53	b +4.93	Feb. 1, 1902	.80	Dec. 19	4.70	+3.90
Grays Point, Mo c	48.0	321.25	....	May 22, 1892	35.00	....	....	....	....	....	....	....	....
Cairo, Ill	0	290.84	....	Feb. 27, 1883	52.17	Mar. 16, 17	50.57	-1.60	Dec. 31, 1880	.95	Dec. 20	2.85	+1.90
	Below												
Columbus, Ky	21.6	286.76	....	Feb. 26, 1883	45.88	Mar. 17	44.80	1.08	Nov. 6-8, 1895	.05	Dec. 20	2.99	+2.94
Morrison Landing, Mo. d	69.0	275.80	....	Feb. 24, 1884	41.50	....	....	....	Nov. 11-14, 1879	-.17	....	....	....
New Madrid, Mo	70.3	275.72	....	Mar. 29, 1897	40.27	Mar. 17	39.56	- .71	Nov. 6-8, 1895	.55	Dec. 21	2.80	+2.25
Cottonwood Point, Mo	122.5	260.67	....	Mar. 21-23, 1897	39.35	Mar. 19	39.96	+ .61	Nov. 6-8, 1895	-3.35	do	.40	+3.75
Fulton, Tenn	178.4	228.55	....	Apr. 10, 1898	38.30	do	40.15	+1.85	Nov. 7, 8, 1895	.16	Dec. 22	1.30	+1.14
Memphis, Tenn	230.0	203.97	....	Mar. 30, 1897	37.66	Mar. 20	40.10	e +2.44	Nov. 6-9, 1895	2.65	Dec. 23	.95	+3.60
Mhoon Landing, Miss	276.3	181.48	....	Apr. 4, 1897	41.60	Mar. 25	41.81	+ .21	Nov. 6-11, 1895	-7.80	do	?-3.70	+4.10
Helena, Ark	306.5	161.98	....	do	51.75	Mar. 26, 27	51.00	− .75	Nov. 8, 9, 1895	-3.00	do	2.80	+5.80
Sunflower Landing, Miss	352.7	147.08	....	Mar. 27, 1897	47.17	Mar. 27, 28	48.00	+ .83	Nov. 12-14, 1895	-1.50	Dec. 24	2.90	+4.40
Mouth White River, Ark	393.2	128.78	....	Mar. 29, 1897	52.42	Mar. 28, 29	53.70	+1.28	Dec. 28, 1872	.00	do	? 5.10	+5.10

a High water of June 28, 1844, would read 41.4 feet.
b 1908 was 0.8 foot higher than 1892 at Grays Point.
c Gauge transferred to Cape Girardeau in 1896.
d Gauge transferred to New Madrid in 1898.
e Allowing for river slope this difference becomes +3.1.

TABLE No. 1.—*Highest and lowest gauge readings of 1903*—Continued.

MISSISSIPPI RIVER—Continued.

Station.	Distance from Cairo.	Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean Gulf level.	Highest.					Lowest.				
				Prior to 1903.		1903.		Difference compared with previous highest.	Prior to 1903.		1903.		Difference compared with previous lowest.
				Date.	Gauge reading.	Date.	Gauge reading.		Date.	Gauge reading.	Date.	Gauge reading.	
	Miles above.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Arkansas City, Ark	438.3	116.41	....	Mar. 29, 1897	51.90	Mar. 27, 28	52.90	+1.00	Nov. 9, 10, 1895	−3.60	Dec. 24	2.10	+5.70
Greenville, Miss	478.3	108.00	....	.....do	46.75	Mar. 27	49.10	+2.35	Nov. 10, 11, 1895	−2.55	Dec. 25	2.70	+5.25
Lake Providence, La	542.3	89.62	....	Mar. 30, 1897	44.54	.....do	46.48	+1.94	Nov. 17, 1895	−5.30	Dec. 26, 27	.70	+6.00
Vicksburg, Miss	599.3	66.04	....	Apr. 16, 1897	52.48	Mar. 28	51.80	− .68	Nov. 13, 14, 1895	−6.50	Dec. 27	.27	+6.77
St. Joseph, La	648.3	52.71	....	Apr. 17, 1897	47.85	.....do	48.07	+ .22	Nov. 13, 1895	−9.30	Dec. 27, 28	−4.25	+5.05
Natchez, Miss	700.3	36.89	....	May 2, 1897	49.82	Mar. 28–30, Apr. 2.	50.35	+ .53	Nov. 13–15, 1895	− .85	Dec. 28	4.20	+5.05
Red River Landing, La	765.3	....	3.57	May 14, 15, 1897	50.20	Apr. 8, 9	50.08	− .12	Nov. 14, 1895	− .60	Dec. 28, 29	2.80	+3.40
Bayou Sara, La	799.8	....	4.15	May 13–15, 1897	43.70	Apr. 8–10	43.34	− .36	Nov. 16, 1895	−2.70	.....do	− .80	+1.90
Baton Rouge, La	833.3	....	.42	.....do	40.65	Apr. 7, 8, 10	40.05	− .60	Nov. 14, 1894	.45	Dec. 29, 30	1.80	+1.35
Plaquemine, La	854.1	....	.44	May 13–17, 1897	36.25	Apr. 5, 7, 8	36.12	− .13	.....do	− .94	Dec. 30	.45	+1.39
Donaldsonville, La	885.4	....	1.01	May 13, 1897	32.75	Apr. 7	32.23	− .52	Nov. 11, 1894	1.00	Dec. 31	1.45	+ .45
College Point, La	904.5	....	.29	May 15, 1897	27.95	Apr. 5, 6	27.81	− .14	Nov. 14, 1894	− .91	Dec. 28	− .50	+ .41
Carrollton, La	957.0	....	.13	May 13, 1897	19.17	.....do	19.42	+ .25	Dec. 27, 1872	−1.60	Dec. 28–31	− .10	+1.50
Algiers, La	966.0	....	2.61	....	....	Mar. 25, 26, 29	19.90	....	....	....	Dec. 30	2.20	....
Fort Jackson, La	1,039.0	....	1.68	Apr. 22, 23, 29, May 14, 16, 1897.	7.20	Mar. 27	8.05	+ .85	Dec. 7, 1893; Nov. 12, 14, 1894.	.30	Dec. 31	.65	+ .35

TABLE No. 1.—*Highest and lowest gauge readings of 1903*—Continued.

[TRIBUTARIES OF MISSISSIPPI RIVER AND THE ATCHAFALAYA.]

River.	Station.	Approximate distance of station from—		Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean Gulf level.	Highest.					Lowest.				
						Prior to 1903.		1903.		Difference compared with previous highest.	Prior to 1903.		1903.		Difference compared with previous lowest.
						Date.	Gauge reading.	Date.	Gauge reading.		Date.	Gauge reading.	Date.	Gauge reading.	
			Miles.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Arkansas	Little Rock, Ark	Mouth	176	241.53	......	May 21, 1892	31.20	June 2	26.20	− 5.00	Nov. 20, 1887	[a]2.00	Dec. 11-12, 15-24	4.10	+2.10
Do.[b]	Pine Bluff, Ark	Mouth	110	200.34	......	May 22, 1892	30.50	......	......	......	Nov. 20-23, 1887	− .40	......	......	......
Atchafalaya	Barbre Landing, La	Head	0	......	3.91	May 13-14, 97	50.95	Apr. 7-11	50.60	− .35	Oct. 26, 1897	−1.77	Dec. 28-30	1.30	+3.07
Do.[b]	Simmesport, La	Head	4	24.17	......	May, 1897	49.22	......	......	......	Nov. 8, 1891	−1.60	......	......	......
Do	West Melville, La	Head	27	......	−.10	Mar. 31, 1882	37.00	Apr 4-5	38.70	+ 1.70	Nov. 12-13, 1894	1.00	Dec. 29	3.90	+2.90
Cumberland	Nashville, Tenn	Cairo	244	334.80	......	Jan. 22, 1882	55.30	Mar. 9	40.60	−14.70	Oct. 15-16, 1878	− .40	Oct. 30-31	.88	+1.28
Illinois	Peoria, Ill	Mouth	160	454.66	......	May 9, 1892	21.90	Mar. 12-13	19.30	− 2.60	Oct. 7, 1890	2.60	Aug. 3, 24-26	8.40	+5.80
Do.[b]	Beardstown, Ill	Mouth	86	444.29	......	——, 1882	21.30	......	......	......	Aug. 11-12, 1887	.00	......	......	......
Missouri	Kansas City, Mo	Mouth	388	737.44	......	May 21, 1892	24.90	June 1-2	35.00	+10.10	Dec. 2, 1874	1.50	Dec. 16	3.50	+2.00
Do.[b]	Coles Creek, Mo	Mouth	107	433.97	......	May 15, 1892	96.76	......	......	......	Dec. 24, 1897	70.70	......	......	......
Do	Hermann, Mo	Mouth	103	502.17	......	do	[c]24.80	June 6	29.50	+ 4.70	Dec. 22, 1897	− .60	Dec. 16	2.60	+3.20
Ohio	Cincinnati, Ohio	Mouth	504	447.62	......	Feb. 14, 1884	71.06	Mar. 5	53.20	−17.86	Sept. 18, 1881	1.92	Oct. 7, Nov. 11-16	4.50	+2.58
Do	Louisville (upper), Ky	Mouth	364	419.76	......	Feb. 16, 1884	46.60	Mar. 9	28.50	−18.10	Sept. 10-14, 18-22, 1881; Nov. 14-16, 1895.	1.70	Dec. 20	2.80	+1.10
Do	Louisville (lower), Ky	Mouth	364	392.85	......	do	72.00	do	54.30	−17.70	Oct. 17-18, 1872	1.60	Nov. 14	3.90	+2.30
Do	Evansville, Ind	Mouth	183	349.30	......	Feb. 19, 1884	48.80	Mar. 11	42.40	− 6.40	Nov. 7-8, 1895	− .30	Oct. 17	2.90	+3.20
Do	Paducah, Ky	Mouth	45	300.46	......	Feb. 23, 1884	54.25	Mar. 15-16	47.60	− 6.65	Oct. 30-Nov. 4, 1895	− .70	Dec. 18-19	1.60	+2.30
Do	Cairo, Ill	Mouth	1	290.84	......	Feb. 27, 1883	52.17	Mar. 16-17	50.57	− 1.60	Dec. 24, 1871	−1.00	Dec. 20	2.85	+3.85
Ouachita	Camden, Ark	Mouth Red River.	325	......	71.10	May 12, 1882	46.00	Feb. 20	39.60	− 6.40	Aug. 29-30, 1887	1.80	Dec. 9-14	3.60	+1.80
Do	Monroe, La	Mouth Red River.	175	......	30.97	——, 1882	48.60	Mar. 26-29	44.50	− 4.10	Sept.-Nov., 1897 and 1899.	.00	Nov. 26-Dec. 13	1.40	+1.40
Red	Fulton, Ark	Mouth	508	......	224.48	July 17, 1876	35.75	Mar. 14	31.15	− 4.60	Oct. 20-22, 1896	.10	Dec. 16-17	5.30	+5.20
Do.[b]	Garland, Ark	Mouth	450	......	203.16	Mar. 24, 1894	28.50	......	......	......	Sept. 22-25, 1896	−0.20	......	......	......
Do	Shreveport, La	Mouth	320	......	140.99	May 28, 1892	35.70	Mar. 22-23	33.10	− 2.60	Dec. 2-4, 1894	−5.50	Nov. 29, Dec. 2-24	−2.00	+3.50
Do	Alexandria, La	Mouth	110	......	44.18	June 12-13, 92	38.25	Mar. 28	36.05	− 2.20	Sept. 29, 1881	−3.70	Dec. 10-12	−1.00	+2.70

[a] Low water of 1879, adopted by the U. S. Engineer office at Little Rock, Ark., reads 2.01 feet on present gauge.

[b] Discontinued.

[c] H. W. of June, 1844, would read 35.6 feet.

TABLE No. 1.—*Highest and lowest gauge readings of 1903*—Continued.

[TRIBUTARIES OF MISSISSIPPI RIVER AND THE ATCHAFALAYA]—Continued.

River.	Station.	Approximate distance of station from—	Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean Gulf level.	Highest.					Lowest.				
					Prior to 1903.		1903.		Difference compared with previous highest.	Prior to 1903.		1903.		Difference compared with previous lowest.
					Date.	Gauge reading.	Date.	Gauge reading.		Date.	Gauge reading.	Date.	Gauge reading.	
		Miles.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
St. Francis...	Bridge, St. Louis, Iron Mountain and Southern Rwy.	Mouth... 194	......	......	Apr. 4-6, 1897	41.60	Apr. 2-3...	32.90	− 8.70	Nov. 3-11, 1901....	− .05	Oct. 23-Nov. 16 ...	.40	+ .45
Do.[a].....	Wittsburg, Ark........	Mouth... 180	......	......	Apr. 28, 1886	42.02	....	......	....	Oct. 27-31, Nov. 10-14, 1892.	−3.60	....	......	....
Tennessee ...	Chattanooga, Tenn ...	Cairo 495	651.90	......	Mar. 1, 1875	54.00	Apr. 11....	31.80	−22.20	Sept. 11-14, 1881, and Sept. 19, 1883.	.00	Sept. 30, Oct. 7, Oct. 28-30.	.60	+ .60
Do.......	Florence, Ala	Cairo 300	418.08	......	Mar. 19, 1897	32.20	Mar. 6	18.82	−13.38	Oct., 1872; Sept. 18, 1878.	− .76	Oct. 5-7...........	− .50	+ .26
Do.......	Johnsonville, Tenn...	Cairo 139	343.30	......	——, 1882	48.00	Mar. 11 ...	33.70	−14.30	Unknown	− .10	Oct. 6-8, 10, 27-28, 31-Nov. 2.	.00	+ .10
Wabash	Mount Carmel, Ill.....	Cairo 190	397.86	......	Aug. 7, 1875	28.30	Mar. 12 ...	22.30	− 6.00	Nov. 7-23, 1895....	− .20	Oct. 2-3...........	.40	+ .60
White	Jacksonport, Ark	Mouth... 360	......	......	Mar. 14, 1890	33.35	....do	29.77	− 3.58	Dec. 24, 1872......	−1.10	Nov. 27	.05	+1.15
Do.......	Clarendon, Ark.......	Mouth... 134	158.90	......	Mar. 20, 1890	36.63	Mar. 20....	32.63	− 4.00	Nov. 22, 1887......	4.07	Dec. 11	5.90	+1.83
Yazoo	Yazoo City, Miss......	Mouth... 65	93.34	......	——, 1882	36.50	Apr. 5-8...	28.70	− 7.80	1875...............	−4.30	Nov. 1-11	2.50	+6.80

[a] Discontinued.

TABLE No. 2. *Maximum readings on high-water and regular gauges on the Mississippi River from Cairo to the Passes during the flood of 1903, with readings of 1897 for comparison.*

Name and number of gauge.	Distance from Cairo.	Date of highest reading in 1903.	Elevation above Memphis datum			Difference between 1903 and 1890.	Regular gauge readings.		
			1903.	1897.	1890.		1903.	Previous highest	
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Year.*	*Feet.*
Cairo	0	Apr. 5	326.8	329.4	328.3	1.5	49.1	1883	52.17
182	4.4	do	324.7	326.5	326.2	1.5			
181	9.0			325.3					
180	12.5	Apr. 3	322.7	324.3	323.7	1.0			
179	17.8	Apr. 5	320.0	321.4	320.8	.8			
Columbus	21.5	do	317.5	318.7	318.1	.6	43.91	1883	45.58
178	27.0	do	315.3	316.5	316.2	.9			
177	33.0	Apr. 2	313.4	314.2	314.0	.6			
176	38.5	Apr. 6	311.1	312.0	311.6	.5			
175	44.4	Apr. 7	308.8	309.7	309.4	.6			
174	49.8	Apr. 6	306.8	308.0	307.4	.6			
173	54.0	do	305.9	306.9	306.5	.6			
172	59.5	do	305.2	306.4	306.0	.8			
171	64.5	do	303.2	304.9					
New Madrid	70.5	do	301.2	302.9	302.1	.9	38.06		
170	73.3	Apr. 7-8	299.4	300.8					
169	78.5	Apr. 4	296.0	298.5	297.5	1.5			
168	84.8	Apr. 7	294.1	295.5	295.6	1.5			
167	89.5	Apr. 6	291.2	293.1	292.3	1.1			
166	95.0		288.4	289.9	289.4	1.0			
165	99.5	Apr. 6-7	286.2	288.0	287.8	1.6			
164	104.1		284.9	286.4	286.2	1.3			
163	109.5	Apr. 7	281.8	283.3	283.4	1.6			
162	114.5		279.7	281.2	281.4	1.7			
161	118.5	Apr. 8	277.4	278.8	279.1	1.7			
Cottonwood Point	123.0	do	275.7	276.8	277.6	1.9	38.15	1883	40.09
160	127.4	do	274.4	275.7	276.3	1.9			
159	130.5		273.1	274.0	274.9	1.8			
158	135.0		272.2	273.0	273.7	1.5			
157	140.0		270.0	270.8	271.8	1.8			
156	146.0		266.0	268.1					
155	152.8	Apr. 9	262.5	264.0	265.1	2.6			
154	158.1		260.0	261.4	262.6	2.6			
153	161.8			260.2	261.6				
152	167.5			258.3	260.0				
151	172.8			254.8	257.2				
Fulton	175.4	Apr. 10	252.8	252.9	255.6	2.8	37.4	1883	40.15
150	180.2	do	251.2	251.2	253.9	2.7			
149	188.5	do	247.9	247.5	250.4	2.5			
148	192.6	do	246.0	245.7	247.8	1.8			
147	197.5		245.6	244.8	246.8	1.2			
146a	203	Apr. 10-11	241.9	240.1	243.8	1.9			
145	208.0		240.4	238.4	243.0	2.6			
144	212.8			235.5	238.8				
143	220.4	Apr. 11	236.1	233.3	236.7	.6			
142	225.5		232.1	229.3	232.7	.6			
Memphis	230.0	Apr. 11	229.9	227.9	231.0	1.1	39.30	[illegible]	40.12
141	235.0	do	227.7	225.1	228.4	.7			
140	239.5	do	225.4	222.9	225.6	.2			
139a	243.5	do	223.8		224.4	.6			
139	246.5	do	220.3	218.2	221.6	1.3			
137	256.4	do	216.8	215.4	217.5	.7			
136	261.3	Apr. 12	213.9	213.6	215.0	1.1			
135	266.8	do	212.0	211.8	213.2	1.2			
134	271.0	Apr. 10	209.8	210.8	211.0	1.2			
Mhoon's Landing	275.3	Apr. 12-13	208.6	210.0	210.2	1.6	40.30	1883	41.80
133	280.5	Apr. 13	207.4	209.5	209.2	1.8			
132a	284.4	do	204.5	207.6	206.6	2.1			
131	289.5	Apr. 14	202.6	203.6	205.6	3.0			
130	293.5	Apr. 14	200.5	203.0	204.0	3.5			
129	297.8	Apr. 14-15	200.2	204.6	203.7	3.5			
128	301.5	Apr. 13	199.0	203.2	202.0	3.0			
Helena	307.5	Apr. 14-15	198.5	200.6	199.8	1.3	47.12	1897	51.75
127	312.5	Apr. 14-16	194.1	197.5	197.2	3.1			
126	317.8	do	192.4	195.2	195.4	3.0			
125	322.5	Apr. 14	190.3	190.2	193.2	2.9			
124	329.3	Apr. 15-16	188.2	190.9	191.2	3.0			
123	334.5	Apr. 15-16	186.6	189.4	189.5	2.9			
122	339.0	Apr. 16	183.7	185.8	186.6	2.9			
121	342.5	do	182.6	184.8	185.5	2.9			
120	346.8	Apr. 17	180.6	183.1	184.0	3.4			
Sunflower Landing	352.7	Apr. 15-17	178.4	181.1	182.0	3.6	44.30	1883	48.00
119	357.0	Apr. 16-18	176.7	179.5	180.6	3.9			
118	362.0	Apr. 17-18	175.6	178.5	179.4	3.8			

the mouth of the Illinois River; also the discharge of the Illinois River was measured three times in all. The soundings and velocity stations were located by transit and stadia. The presence of the dike in the Mississippi River at the lower section affected the flow and the conditions were unfavorable for reliable measurements. The results are given in Table No. 4.

During the recent high water on the Mississippi River the discharges were measured at the maximum stage at all the regular discharge stations, as follows: Columbus, Ky. (21), April 3 to 7, four by meter and two by floats; Helena, Ark. (306), April 6 to 15, six by meter and two by floats; Chicot City, Ark. (432), April 11 to 21, ten by meter and two by floats; Vicksburg, Miss. (600), April 23, one by meter; Red River Landing, La. (765), April 29 to May 10, three by meter, also the Atchafalaya River at Simmesport, La., April 26 to 28, four by meter and two by floats; Carrollton, La. (957), April 23 to May 3, nine by meter and one by floats.

The observations at Helena and Carrollton were made by a party on the steamer *Vulcan* in charge of Junior Engineer M. A. Bell; all the others were made by a party on the steamer *Mars* in charge of Junior Engineer E. L. Harman.

The discharge of the Mississippi River at Thebes, Ill., 44.5 miles above Cairo, was measured by a party in charge of Assistant Engineer Wm. Gerig, on a small steamboat borrowed from the engineer officer in charge of the district. Eight discharges were measured by meter from April 29 to May 6. The results of these observations have not yet been computed.

Rating of current meters.—All the meters were rated at the settling basins of the city water works near Bissells Point, St. Louis, in August, 1903. These were rated from a skiff drawn over a 200-foot course at varying speeds; for the higher speeds a team of horses was used. Four meters were rated simultaneously by means of the electric chronograph and break-circuit chronometer before referred to. The results were quite satisfactory and the records of the chronograph rolls very perfect. All the rating observations were reduced by method of least squares and the results tabulated.

All the meters used during the high water were also rated in the field at conclusion of the discharge work by the parties using them. The results of these have not yet been reduced.

MISCELLANEOUS.

The daily stages of the Mississippi River and its principal tributaries for 1903 have been prepared and are being printed in the usual pamphlet form; this will comprise about 130 pages; some additional stations were printed this year at the request of the committee on gauges. The daily readings of gauges at stations on the main river and tributaries were sent out monthly in blueprint.

The proceedings of the Commission at the eighty-ninth, ninetieth, and ninety-first sessions, and the monthly reports of operations of the secretary and district officers, have been printed. The scientific records and drawings of the secretary's office have been cared for and the catalogues and card indexes kept up. Various information and data concerning the Mississippi River have been supplied on request.

I beg to acknowledge the valuable assistance of Messrs. E. J. Thomas, junior engineer, and E. E. Whitehead, recorder, who have been engaged in the computations and other office work while not in the field. Messrs. F. C. Hall and W. M. Garrott, recorders, also assisted in the office work, mainly copying gauge records and filing maps, and have shown faithfulness and diligence in their work.

Respectfully submitted.

Kivas Tully,
Assistant Engineer.

Capt. Wm. B. Ladue,
Corps of Engineers U. S. Army,
Secretary Mississippi River Commission.

TABLE No. 1.—*Highest and lowest gauge readings of 1903.*

MISSISSIPPI RIVER.

Station.	Distance from Cairo.	Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean Gulf level.	Highest.					Lowest.				
				Prior to 1903.		1903.		Difference compared with previous highest.	Prior to 1903.		1903.		Difference compared with previous lowest.
				Date.	Gauge reading.	Date.	Gauge reading.		Date.	Gauge reading.	Date.	Gauge reading.	
	Miles above.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Aitkin, Minn	1,086.0	1,206.76	....	1899	15.30	Oct. 14, 15	18.05	−2.25	July 29, 1902	1.30	June 25	1.60	+0.30
St. Paul, Minn	886.0	704.57	....	Apr. 29, 1881	19.70	Oct. 14	13.50	−6.20	Aug. 6, 1894; Mar. 21, 1895.	.20	Jan. 30	2.50	+2.30
Hastings, Minn	850.0	690.79	....	Apr. 30, 1881	18.00	Oct. 12–14	13.80	−4.20	Nov. 23, 1892	− .70	Feb. 16–23	1.50	+2.20
Winona, Minn	760.0	660.34	....	June 18, 1880	16.87	Sept. 19, 20	14.60	−2.27	Dec. 30, 1889	−1.33	Feb. 19	2.30	+3.63
Prairie du Chien, Wis	668.0	625.59	....	June 22, 1880	21.30	Sept. 25	16.70	−4.60	Nov. 26, 1898	.10	Nov. 26	3.70	+3.60
Rock Island, Ill	510.7	562.37	....	June 27, 1892	19.40	Oct. 1	13.65	−5.75	Jan. 5, 6, 1890	− .90	Dec. 2	2.00	+2.90
Burlington, Iowa	427.6	531.25	....	May 18, 19, 1888; June 30, 1892.	17.60	June 5, 6	14.90	−2.70	Dec. 4, 5, 1895	−1.10	Dec. 6	1.80	+2.90
Nashville, Iowa	393.6	516.86	....	May 17, 18, 1888	12.00	June 6	10.55	−1.45	Jan. 7, 1890	− .50	Dec. 14	.80	+1.30
Hannibal, Mo	329.4	469.60	....	May 17, 1888	21.58	June 8	22.50	+ .92	Jan. 9, 1890	−1.75	Dec. 14, 15	.50	+2.25
Grafton, Ill	233.0	424.09	....	May 18, 1892	25.78	June 11	28.70	+2.97	Dec. 9, 1895	− .90	Dec. 16	2.50	+3.40
St. Louis, Mo	190.8	400.23	....	May 19, 1892	[a] 35.95	June 10	38.00	+2.05	Jan. 2, 1900	−2.52	Dec. 18	.55	+3.07
Chester, Ill	115.5	361.30	....	May 21, 1892	31.20	June 13, 14	33.30	+2.10	Jan. 3, 1900	−4.10	.....do	1.40	+5.50
Cape Girardeau, Mo	54.5	324.97	....	Apr. 12, 13, 1897	31.60	June 14	36.53	[b] +4.93	Feb. 1, 1902	.80	Dec. 19	4.70	+3.90
Grays Point, Mo.[c]	48.0	321.28	....	May 22, 1892	35.00	....	....	....	....	....	....	....	....
Cairo, Ill	0	290.84	....	Feb. 27, 1883	52.17	Mar. 16, 17	50.57	−1.60	Dec. 31, 1880	.95	Dec. 20	2.85	+1.90
	Below.												
Columbus, Ky	21.6	286.76	....	Feb. 26, 1883	45.58	Mar. 17	44.50	−1.08	Nov. 6–8, 1895	.05	Dec. 20	2.99	+2.94
Morrisson Landing, Mo.[d]	69.0	275.80	....	Feb. 24, 1884	41.50	....	....	....	Nov. 11–14, 1879	− .17	....	....	....
New Madrid, Mo	70.3	275.72	....	Mar. 29, 1897	40.27	Mar. 17	39.56	− .71	Nov. 6–8, 1895	.55	Dec. 21	2.80	+2.25
Cottonwood Point, Mo	122.5	250.67	....	Mar. 21–23, 1897	39.35	Mar. 19	39.96	+ .61	Nov. 5–8, 1895	−3.35	.....do	.40	+3.75
Fulton, Tenn	175.4	228.55	....	Apr. 10, 1898	38.30	.....do	40.15	+1.85	Nov. 7, 8, 1895	.16	Dec. 22	1.30	+1.14
Memphis, Tenn	230.0	203.97	....	Mar. 20, 1897	37.66	Mar. 20	40.10	[e] +2.44	Nov. 6–9, 1895	−2.65	Dec. 23	.95	+3.60
Mhoon Landing, Miss	276.3	181.48	....	Apr. 4, 1897	41.60	Mar. 25	41.81	+ .21	Nov. 6–11, 1895	−7.80	.....do	?−3.70	+4.10
Helena, Ark	306.5	161.98	....	.....do	51.75	Mar. 26, 27	51.00	− .75	Nov. 8, 9, 1895	−3.00	.....do	2.80	+5.80
Sunflower Landing, Miss	352.7	147.08	....	Mar. 27, 1897	47.17	Mar. 27, 28	48.00	+ .83	Nov. 12–14, 1895	−1.50	Dec. 24	2.90	+4.40
Mouth White River, Ark	393.2	128.78	....	Mar. 29, 1897	52.42	Mar. 28, 29	53.70	+1.28	Dec. 28, 1872	.00	.....do	? 5.10	+5.10

[a] High water of June 28, 1844, would read 41.4 feet.
[b] 1903 was 0.8 foot higher than 1892 at Grays Point.
[c] Gauge transferred to Cape Girardeau in 1896.
[d] Gauge transferred to New Madrid in 1893.
[e] Allowing for river slope this difference becomes +3.1.

TABLE No. 1.—*Highest and lowest gauge readings of 1903*—Continued.

MISSISSIPPI RIVER—Continued.

Station.	Distance from Cairo.	Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean Gulf level.	Highest.					Lowest.				
				Prior to 1903.		1903.		Difference compared with previous highest.	Prior to 1903.		1903.		Difference compared with previous lowest.
				Date.	Gauge reading.	Date.	Gauge reading.		Date.	Gauge reading.	Date.	Gauge reading.	
	Miles above.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Arkansas City, Ark	438.8	116.44		Mar. 29, 1897	51.90	Mar. 27, 28	52.90	+1.00	Nov. 9, 10, 1895	−3.60	Dec. 24	2.10	+5.70
Greenville, Miss	478.3	108.00		do	46.75	Mar. 27	49.10	+2.35	Nov. 10, 11, 1895	−2.55	Dec. 25	2.70	+5.25
Lake Providence, La	512.3	89.62		Mar. 30, 1897	44.54	do	46.48	+1.94	Nov. 17, 1895	−5.30	Dec. 26, 27	.70	+6.00
Vicksburg, Miss	599.3	66.04		Apr. 16, 1897	52.48	Mar. 28	51.80	− .68	Nov. 13, 14, 1895	−6.50	Dec. 27	.27	+6.77
St. Joseph, La	648.3	52.74		Apr. 17, 1897	47.85	do	48.07	+ .22	Nov. 13, 1895	−9.30	Dec. 27, 28	−4.25	+5.05
Natchez, Miss	700.8	36.89		May 2, 1897	49.82	Mar. 28–30, Apr. 2.	50.35	+ .53	Nov. 13–15, 1895	− .85	Dec. 28	4.20	+5.05
Red River Landing, La	765.3		3.57	May 14, 15, 1897	50.20	Apr. 8, 9	50.08	− .12	Nov. 14, 1895	− .60	Dec. 28, 29	2.80	+3.40
Bayou Sara, La	799.8		4.15	May 13–15, 1897	43.70	Apr. 8–10	43.34	− .36	Nov. 16, 1895	−2.70	do	− .80	+1.90
Baton Rouge, La	833.3		− .42	do	40.65	Apr. 7, 8, 10	40.05	− .60	Nov. 14, 1894	.45	Dec. 29, 30	1.80	+1.35
Plaquemine, La	854.1		.44	May 13–17, 1897	36.25	Apr. 5, 7, 8	36.12	− .13	do	− .94	Dec. 30	.45	+1.39
Donaldsonville, La	885.4		−1.01	May 13, 1897	32.75	Apr. 7	32.23	− .52	Nov. 11, 1894	1.00	Dec. 31	1.45	+ .45
College Point, La	904.5		.29	May 15, 1897	27.95	Apr. 5, 6	27.81	− .14	Nov. 14, 1894	− .91	Dec. 28	− .50	+ .41
Carrollton, La	957.0		− .13	May 13, 1897	19.17	do	19.42	+ .25	Dec. 27, 1872	−1.60	Dec. 28–31	− .10	+1.50
Algiers, La	966.0		−2.64			Mar. 25, 26, 29	19.90				Dec. 30	2.20	
Fort Jackson, La	1,039.0		−1.68	Apr. 22, 23, 29, May 14, 16, 1897.	7.20	Mar. 27	8.05	+ .85	Dec. 7, 1893; Nov. 12, 14, 1894.	.30	Dec. 31	.65	+ .35

TABLE No. 1.—*Highest and lowest gauge readings of 1903*—Continued.

[TRIBUTARIES OF MISSISSIPPI RIVER AND THE ATCHAFALAYA.]

River.	Station.	Approximate distance of station from—	Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean Gulf level.	Highest.					Lowest.				
					Prior to 1903.		1903.		Difference compared with previous highest.	Prior to 1903.		1903.		Difference compared with previous lowest.
					Date.	Gauge reading.	Date.	Gauge reading.		Date.	Gauge reading.	Date.	Gauge reading.	
		Miles.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Arkansas	Little Rock, Ark	Mouth... 176	241.53	......	May 21, 1892	31.20	June 2	26.20	− 5.00	Nov. 20, 1887	[a] 2.00	Dec. 11-12, 15-24	4.10	+2.10
Do.[b]	Pine Bluff, Ark	Mouth... 110	200.34	......	May 22, 1892	30.50	......	......	......	Nov. 20-23, 1887	− .40	......	......	......
Atchafalaya	Barbre Landing, La	Head 0	......	3.91	May 13-14, 97	50.95	Apr. 7-11	50.60	− .35	Oct. 26, 1897	−1.77	Dec. 28-30	1.30	+3.07
Do.[b]	Simmesport, La	Head 4	24.17	......	May, 1897	49.22	......	......	......	Nov. 8, 1891	−1.60	......	......	......
Do	West Melville, La	Head 27	......	−.10	Mar. 31, 1882	37.00	Apr 4-5	38.70	+ 1.70	Nov. 12-13, 1894	1.00	Dec. 29	3.90	+2.90
Cumberland	Nashville, Tenn	Cairo 244	334.80	......	Jan. 22, 1882	55.30	Mar. 9	40.60	−14.70	Oct. 15-16, 1878	− .40	Oct. 30-31	.88	+1.28
Illinois	Peoria, Ill	Mouth... 160	454.66	......	May 9, 1892	21.90	Mar. 12-13	19.30	− 2.60	Oct. 7, 1890	2.60	Aug. 3, 24-26	8.40	+5.80
Do.[b]	Beardstown, Ill	Mouth... 86	444.29	......	——, 1882	21.30	......	......	......	Aug. 11-12, 1887	.00	......	......	......
Missouri	Kansas City, Mo	Mouth... 388	737.44	......	May 21, 1892	24.90	June 1-2	35.00	+10.10	Dec. 2, 1874	1.50	Dec. 16	3.50	+2.00
Do.[b]	Coles Creek, Mo	Mouth... 107	433.97	......	May 15, 1892	96.76	......	......	......	Dec. 24, 1897	70.70	......	......	......
Do	Hermann, Mo	Mouth... 103	502.17	......	.....do	[c] 24.80	June 6	29.50	+ 4.70	Dec. 22, 1897	− .60	Dec. 16	2.60	+3.20
Ohio	Cincinnati, Ohio	Mouth... 504	447.62	......	Feb. 14, 1884	71.06	Mar. 5	53.20	−17.86	Sept. 18, 1881	1.92	Oct. 7, Nov. 11-16	4.50	+2.58
Do	Louisville (upper), Ky.	Mouth... 364	419.76	......	Feb. 16, 1884	46.60	Mar. 9	28.50	−18.10	Sept. 10-14, 18-22, 1881; Nov. 14-16, 1895.	1.70	Dec. 20	2.80	+1.10
Do	Louisville (lower), Ky.	Mouth... 364	392.85	......	.....do	72.00	.....do	54.30	−17.70	Oct. 17-18, 1872	1.60	Nov. 14	3.90	+2.30
Do	Evansville, Ind	Mouth... 183	349.30	......	Feb. 19, 1884	48.80	Mar. 11	42.40	− 6.40	Nov. 7-8, 1895	− .30	Oct. 17	2.90	+3.20
Do	Paducah, Ky	Mouth... 45	300.46	......	Feb. 23, 1884	54.25	Mar. 15-16	47.60	− 6.65	Oct. 30-Nov. 4, 1895	− .70	Dec. 18-19	1.60	+2.30
Do	Cairo, Ill	Mouth... 1	290.84	......	Feb. 27, 1883	52.17	Mar. 16-17	50.57	− 1.60	Dec. 24, 1871	−1.00	Dec. 20	2.85	+3.85
Ouachita	Camden, Ark	Mouth... 325 Red River.	......	71.10	May 12, 1882	46.00	Feb. 20	39.60	− 6.40	Aug. 29-30, 1887	1.80	Dec. 9-14	3.60	+1.80
Do	Monroe, La	Mouth... 175 Red River.	......	30.97	——, 1882	48.60	Mar. 26-29	44.50	− 4.10	Sept.-Nov., 1897 and 1899.	.00	Nov. 26-Dec. 13	1.40	+1.40
Red	Fulton, Ark	Mouth... 508	......	224.48	July 17, 1876	35.75	Mar. 14	31.15	− 4.60	Oct. 20-22, 1896	.10	Dec. 16-17	5.30	+5.20
Do.[b]	Garland, Ark	Mouth... 450	......	203.16	Mar. 24, 1894	28.50	......	......	......	Sept. 22-25, 1896	−0.20	......	......	......
Do	Shreveport, La	Mouth... 320	......	140.99	May 28, 1892	35.70	Mar. 22-23	33.10	− 2.60	Dec. 2-4, 1894	−5.50	Nov. 29, Dec. 2-24	−2.00	+3.50
Do	Alexandria, La	Mouth... 110	......	44.18	June 12-13, 92	38.25	Mar. 28	36.05	− 2.20	Sept. 29, 1881	−3.70	Dec. 10-12	−1.00	+2.70

[a] Low water of 1879, adopted by the U. S. Engineer office at Little Rock, Ark., reads 2.01 feet on present gauge.

[b] Discontinued.

[c] H. W. of June, 1844, would read 35.6 feet.

TABLE No. 1.—*Highest and lowest gauge readings of 1903*—Continued.

[TRIBUTARIES OF MISSISSIPPI RIVER AND THE ATCHAFALAYA]—Continued.

River.	Station.	Approximate distance of station from—	Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean Gulf level.	Highest.					Lowest.				
					Prior to 1903.		1903.		Difference compared with previous highest.	Prior to 1903.		1903.		Difference compared with previous lowest.
					Date.	Gauge reading.	Date.	Gauge reading.		Date.	Gauge reading.	Date.	Gauge reading.	
		Miles.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
St. Francis	Bridge, St. Louis, Iron Mountain and Southern Rwy.	Mouth ... 194	......	......	Apr. 4-6, 1897	41.60	Apr. 2-3	32.90	− 8.70	Nov. 3-11, 1901	− .05	Oct. 23-Nov. 16	.40	+ .45
Do.[a]	Wittsburg, Ark	Mouth ... 180	......	......	Apr. 28, 1886	42.02	......	......	......	Oct. 27-31, Nov. 10-14, 1892.	−3.60	......	......	......
Tennessee	Chattanooga, Tenn	Cairo 495	651.90	......	Mar. 1, 1875	54.00	Apr. 11	31.80	−22.20	Sept. 11-14, 1881, and Sept. 19, 1883.	.00	Sept. 30, Oct. 7, Oct. 28-30.	.60	+ .60
Do	Florence, Ala	Cairo 300	418.06	......	Mar. 19, 1897	32.20	Mar. 6	18.82	−13.38	Oct., 1872; Sept. 18, 1878.	− .76	Oct. 5-7	− .50	+ .26
Do	Johnsonville, Tenn	Cairo 139	343.30	......	——, 1882	48.00	Mar. 11	33.70	−14.30	Unknown	− .10	Oct. 6-8, 10, 27-28, 31-Nov. 2.	.00	+ .10
Wabash	Mount Carmel, Ill	Cairo 190	397.86	......	Aug. 7, 1875	28.30	Mar. 12	22.30	− 6.00	Nov. 7-23, 1895	− .20	Oct. 2-3	.40	+ .60
White	Jacksonport, Ark	Mouth ... 360	......	......	Mar. 14, 1890	33.35	....do	29.77	− 3.58	Dec. 24, 1872	−1.10	Nov. 27	.05	+1.15
Do	Clarendon, Ark	Mouth ... 134	158.90	......	Mar. 20, 1890	36.63	Mar. 20	32.63	− 4.00	Nov. 22, 1887	4.07	Dec. 11	5.90	+1.83
Yazoo	Yazoo City, Miss	Mouth ... 65	93.34	......	——, 1882	36.50	Apr. 5-8	28.70	− 7.80	1875	−4.30	Nov. 1-11	2.50	+6.80

[a] Discontinued.

TABLE NO. 2.—*Maximum readings on high-water and regular gauges on the Mississippi River from Cairo to the Passes during the flood of 1904, with readings of 1903 for comparison.*

Name and number of gauge.	Distance from Cairo.	Date of highest reading in 1904.	Elevation above Memphis datum.			Difference between 1903 and 1904.	Regular gauge readings.		
			1904.	1897.	1903.		1904.	Previous highest.	
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Year.*	*Feet.*
Cairo	0	Apr. 5	326.8	329.4	328.3	-1.5	49.1	1883	52.17
182	4.4	do	324.7	326.5	326.2	-1.5			
181	9.0			325.3					
180	12.5	Apr. 3	322.7	324.3	323.7	-1.0			
179	17.8	Apr. 5	320.0	321.4	320.8	- .8			
Columbus	21.3	do	317.5	318.7	318.1	- .6	43.91	1883	45.58
178	27.5	do	315.3	316.5	316.2	- .9			
177	33.5	Apr. 2?	313.4	314.2	314.0	- .6			
176	38.5	Apr. 6	311.1	312.0	311.6	- .5			
175	44.3	Apr. 7	308.8	309.7	309.4	- .6			
174	49.8	Apr. 6	306.8	308.0	307.4	- .6			
173	54.0	do	305.9	306.9	306.5	- .6			
172	59.5	do	305.2	306.4	306.0	- .8			
171	64.5	do	303.2	304.9					
New Madrid	70.3	do	301.2	302.9	302.1	- .9	38.66		
170	73.3	Apr. 7-8	299.5	300.8					
169	78.9	Apr. 4	?295.6	298.3	297.5	-1.9			
168	84.8	Apr. 7	294.1	296.3	295.6	-1.5			
167	89.5	Apr. 6	291.2	293.1	292.3	-1.1			
166	95.0		288.4	289.9	289.4	-1.0			
165	99.3	Apr. 6-7	286.2	288.0	287.8	-1.6			
164	104.1		284.9	286.4	286.2	-1.3			
163	109.3	Apr. 7	281.8	283.3	283.4	-1.6			
162	113.5		279.7	281.2	281.4	-1.7			
161	118.5	Apr. 8	277.4	278.8	279.1	-1.7			
Cottonwood Point	123.0	do	275.7	276.8	277.6	-1.9	38.15	1903	40.09
160	127.4	do	274.4	275.7	276.3	-1.9			
159	130.5		273.1	274.0	?274.9	-1.8			
158	135.0		272.2	273.0	273.7	-1.5			
157	140.0		270.0	270.8	271.8	-1.8			
156	146.0		266.0	268.1					
155	152.8	Apr. 9	262.5	264.0	265.1	-2.6			
154	158.3		260.0	261.4	262.6	-2.6			
153	161.8			260.2	261.6				
152	167.5			258.3	?260.0				
151	172.8			254.8	?257.2				
Fulton	175.4	Apr. 10	252.8	252.9	255.6	-2.8	37.4	1903	40.15
150	180.1	do	251.2	251.2	253.9	-2.7			
149	186.3	do	247.9	247.5	250.4	-2.5			
148	192.6	do	246.0	245.7	247.8	-1.8			
147	197.3		245.6	243.8	246.8	-1.2			
146 a	203.3	Apr. 10-11	241.9	240.1	243.8	-1.9			
145	208.0		240.4	238.4	?243.0	?-2.6			
144	212.8			235.5	?238.8				
143	220.4	Apr. 11	236.1	233.3	236.7	- .6			
142	225.5		232.1	229.3	232.7	- .6			
Memphis	230.0	Apr. 11	229.9	227.9	231.0	-1.1	39.20	1903	40.12
141	235.0	do	227.7	225.1	228.4	- .7			
140	239.5	do	225.4	222.9	225.6	- .2			
139a	243.5	do	223.8		224.4	- .6			
138	249.5	do	220.3	218.2	221.6	-1.3			
137	256.3	do	216.8	215.4	217.5	- .7			
136	261.3	Apr. 12	213.9	213.6	215.0	-1.1			
135	266.8	do	212.0	211.8	213.2	-1.2			
134	271.0	Apr. 10	209.8	210.8	211.0	-1.2			
Mhoon Landing	276.3	Apr. 12-13	208.6	210.0	210.2	-1.6	40.30	1903	41.80
133	280.5	Apr. 13	207.4	209.5	209.2	-1.8			
132a	284.3	do	204.3	207.6	206.6	-2.3			
131	289.5	Apr. 14	202.6	206.6	205.6	-3.0			
130	293.5	Apr. 13	200.5	205.0	204.0	-3.5			
129	297.8	Apr. 14-15	200.2	204.6	203.7	-3.5			
128	301.5	Apr. 13	199.0	203.2	202.0	-3.0			
Helena	306.5	Apr. 14-15	196.5	200.6	199.8	-3.3	47.62	1897	51.75
127	312.5	Apr. 14-16	194.1	197.5	197.2	-3.1			
126	317.8	do	192.3	195.2	195.3	-3.0			
125	323.5	Apr. 14	190.3	193.2	193.2	-2.9			
124	329.3	Apr. 15-16	188.2	190.9	191.2	-3.0			
123	334.5	Apr. 13-15	186.6	189.4	189.5	-2.9			
122	339.0	Apr. 16	183.7	185.8	186.6	-2.9			
121	342.5	do	182.6	184.8	185.5	-2.9			
120	346.8	Apr. 17	180.6	183.1	184.0	-3.4			
Sunflower Landing	352.7	Apr. 15-17	178.4	181.1	182.0	-3.6	44.50	1903	48.00
119	357.0	Apr. 16-18	176.7	179.5	180.6	-3.9			
118	362.0	Apr. 17-18	175.6	178.5	179.4	-3.8			

Table No. 2.—*Maximum readings on high-water and regular gauges on the Mississippi River from Cairo to the Passes during the flood of 1904, etc.*—Continued.

Name and number of gauge.	Distance from Cairo.	Date of highest reading in 1904.	Elevation above Memphis datum.			Difference between 1903 and 1904.	Regular gauge readings.		
			1904.	1897.	1903.		1904.	Previous highest.	
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Year.*	*Feet.*
117	366.8	Apr. 17-20	173.7	176.5	177.8	−4.1			
116	371.8	Apr. 16	172.1	175.1	176.5	−4.4			
115	378.0	Apr. 18	169.3	172.5	173.8	−4.5			
114	383.5	do	167.5	170.4	171.7	−4.2			
113	389.5	Apr. 18-20	166.4	169.3	171.0	−4.6			
Mouth of White River	393.2	do	165.1	168.0	169.3	−4.2	49.50	1903	53.70
112	398.5	do	163.5	166.2	167.6	−4.1			
111a	401.8		162.6	165.3	166.6	−4.0			
110	408.0		161.0	164.0	164.8	−3.8			
109a	411.5	Apr. 18-21	159.6	162.9	163.9	−4.3			
108	416.8	Apr. 18-20	159.0	162.4	163.3	−4.3			
107a	421.5			160.6	162.8				
106a	427.0	Apr. 20-21	156.0	159.7	160.6	−4.6			
105	432.5	do	153.9	157.0	157.8	−3.9			
Arkansas City	438.3	Apr. 19-21	152.3	155.2	156.3	−4.0	49.00	1903	52.96
104a	444.8	Apr. 20-21	150.6	152.4	153.5	−2.9			
103	449.5	do	149.2	151.6	152.7	−3.5			
102a	454.0	do	145.8		149.7	−3.9			
101a	459.8		144.6?	148.2	149.4	−4.8?			
100	463.5	Apr. 20-21	144.8	147.3	148.6	−3.8			
99a	467.0	Apr. 20-22	144.2	147.0	147.8	−3.6			
98	473.5	Apr. 21	140.5	144.0	145.7	−5.2			
Greenville	478.3	Apr. 21-22	138.4	141.6	144.0	5.6	43.55	1903	49.10
97	482.5		137.6	140.5	143.3	−5.7			
96	487.0	Apr. 22-23	136.9	139.7	142.1	−5.2			
95a	489.8	Apr. 21-22	136.4	138.6	141.4	−5.0			
94	495.3	Apr. 20	134.5	136.9	139.5	−5.0			
93a	501.0	do	132.8	134.8	137.3	−4.5			
92	505.5	Apr. 22	130.6	133.8	135.8	−5.2			
91a	510.8	do	127.8	131.2	133.0	−5.2			
90a	517.0	do	126.2		131.0	−4.8			
89	522.5	Apr. 21-23	124.9	127.6	129.9	−5.0			
88	525.8	Apr. 21-22	123.1	125.8	128.0	−4.9			
87	531.5	Apr. 21-24	121.8	123.8	126.2	−4.4			
86	537.5	Apr. 21	120.2	122.3	124.2	−4.0			
Lake Providence	542.3	Apr. 21-24	119.0	121.0	123.0	−4.0	42.50	1903	46.48
85a	546.8	Apr. 22-23	118.3	119.9	122.4	−4.1			
84	552.0	do	116.2	117.9	120.7	−4.5			
83	556.5	do	114.5	116.4	118.6	−4.1			
82	561.3	do	112.7	115.4	117.1	−4.4			
81	568.0	do	109.3	112.2	113.6	−4.3			
80	573.5	Apr. 22-25	107.8	110.9	112.0	−4.2			
79	578.0	Apr. 23	106.3	109.8	110.6	−4.3			
78a	583.0	Apr. 22	104.7	109.2	109.5	−4.8			
77	588.5	Apr. 23-24	102.9	108.0	107.6	−4.7			
76	593.5		101.1	107.0	106.3	−5.2			
Vicksburg	599.3	Apr. 25	99.8	105.4	104.7	−4.9	46.85	1897	52.48
75	602.8	do	98.3	103.2	103.2	−4.9			
74	607.5	do	97.3	102.6	101.9	−4.6			
73	612.5	do	94.6	99.7	99.3	−4.7			
72	617.5	Apr. 26	92.2	97.6	97.2	−5.0			
71	622.0	do	91.4	96.5					
70	627.5	Apr. 27	89.0	94.7	94.5	−5.5			
69	633.0	Apr. 26	86.5	92.4	92.3	−5.8			
68	638.0	Apr. 25	84.4	90.1	90.2	−5.8			
67	642.8		83.0	88.7	88.9	−5.9			
St. Joseph	648.3	Apr. 25-27	82.4	87.5	87.7	−5.3	42.75	1903	48.10
66	655.3	do	79.9	84.4	85.0	−5.1			
65	659.8	do	78.1	83.4	83.8	−5.7			
64	663.8		77.4	82.6	82.9	−5.5			
63	681.0		76.6	81.6	81.8	−5.2			
62	685.5		75.6	79.9	80.7	−5.1			
61	691.5	Apr. 27-28	73.4	77.5	78.5	−5.1			
60	694.0	Apr. 27	71.8	76.2	76.8	−5.0			
Natchez	700.3	Apr. 25-29	69.3	73.6	74.1	−4.8	45.50	1903	50.35
59	705.5	Apr. 25	68.6	72.4	72.9	−4.3			
58	711.3	Apr. 26	67.2	71.5	72.2	−5.0			
57	716.0	Apr. 27	66.6	70.8	71.6	−5.0			
56	720.5	do	64.9	69.3	69.8	−4.9			
55	725.3	do	63.7	68.0	68.7	−5.0			
54	730.5	Apr. 28	61.9	66.3	66.5	−4.6			
53	737.5	do	60.9	65.4	65.5	−4.6			
52	742.8	Apr. 28-29	58.8	64.3	64.4	−5.6			
51a	747.0	Apr. 29	57.8		63.6	−5.8			

TABLE No. 2.—*Maximum readings on high-water and regular gauges on the Mississippi River from Cairo to the Passes during the flood of 1904, etc.*—Continued.

Name and number of gauge.	Distance from Cairo.	Date of highest reading in 1904.	Elevation above Memphis datum.			Difference between 1903 and 1904.	Regular gauge readings.		
			1904.	1897.	1903.		1904.	Previous highest.	
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Year.*	*Feet.*
50	751.5	Apr. 29	56.8	63.2	62.8	−6.0			
49	756.0	Apr. 26–30	55.3	62.3	62.0	−6.7			
48	761.0		54.9	61.5	61.4	−6.5			
Red River Landing	765.3	Apr. 28–30	54.5	60.9	60.7	−6.2	43.80	1897	50.20
47	769.0		53.2	60.0	60.0	−6.8			
46	772.5		53.4?	59.7	59.6	−6.2?			
45	779.8		51.1	58.2	57.9	−6.8			
44	784.8	Apr. 28–30	50.3	57.5	57.3	−7.0			
43	790.5	Apr. 28	48.7	56.3	56.0	−7.3			
42	794.5	Apr. 29–30	47.9	55.5	55.1	−7.2			
Bayou Sara	799.8	Apr. 30–May 1.	47.5	54.6	54.2	−6.7	36.70	1897	43.70
41	803.5	Apr. 30	46.0	53.3	52.8	−6.8			
40	808.0	Apr. 29–30	46.0	53.2	52.8	−6.8			
39	812.5	May 1	44.6	52.2	51.4	−6.8			
38	817.0	Apr. 28–May 1.	43.7	50.6	50.4	−6.7			
37	822.5		42.5	50.1	50.0	−7.5			
36	828.5	May 1	41.3	48.4	47.8	−6.5			
Baton Rouge	833.3	Apr. 29–30	40.6	47.6	47.0	−6.4	33.70	1897	40.65
35	839.5		39.8	46.9	46.4	−6.6			
34	844.3		39.1	45.9	45.5	−6.4			
33	850.0	Apr. 29–May 2.	38.2	44.5	44.4	−6.2			
Plaquemine	854.1	Apr. 30	37.9	44.2	44.1	−6.2	30.00	1897	36.25
32	859.8	Apr. 28	36.9	43.0	42.8	−5.9			
31	864.5	Apr. 28–29	36.1	42.1	42.0	−5.9			
30	870.0	Apr. 30	35.6	41.3	41.0	−5.4			
29	874.5	Apr. 30–May 1.	35.2	40.7	40.6	−5.4			
28	880.0	Apr. 25–26	34.2	40.1	39.7	−5.5			
Donaldsonville	885.4	Apr. 29	33.5	39.1	38.8	−5.3	27.15	1897	32.75
27	889.8	Apr. 28–May 2.	33.4	38.9	38.5	−5.1			
26	895.8	May 1–2	32.4	37.6	37.4	−5.0			
25	900.3	Apr. 29	31.7	36.7	36.2	−4.5			
College Point	904.5	May 1	31.3	36.1	35.9	−4.6	23.22	1897	27.95
24	910.5	Apr. 29	30.2	34.7	34.5	−4.3			
23	914.8	Apr. 29–May 1.	29.6	33.9	33.8	−4.2			
22	919.8	May 1–2	29.1	33.1	33.1	−4.0			
21	925.5	Apr. 27–30	28.4	32.0	32.2	−3.8			
20	930.5	Apr. 28–29	27.5	31.1	31.1	−3.6			
19	934.3	do	27.0	30.2	30.7	−3.7			
18	937.3		26.2	29.4	29.9	−3.7			
17	943.5	Apr. 28	25.6	28.9	29.2	−3.6			
16	947.3	Apr. 27–29	25.2	28.1	28.9	−3.7			
15	953.0	Apr. 28–May 2.	24.2	27.2	27.5	−3.3			
Carrollton	957.0	Apr. 27–29, May 1.	23.9	27.0	27.2	−3.3	16.15	1903	19.42
Algiers	966.0	May 1	22.3				17.20		
14	968.0	May 3	22.4	24.0	24.6	−2.2			
13	973.5	May 2	21.3	23.8	24.1	−2.8			
12	979.3		20.3	22.1	22.8	−2.5			
11	983.5	Apr. 27–30, May 3.	19.6	21.0	21.9	−2.3			
10	989.3	Apr. 25, May 1, 3.	18.8	20.4	21.0	−2.2			
9	993.0	May 1–2	18.1	19.4	20.2	−2.1			
8	999.0	Apr. 25	17.5	19.1	19.5	−2.0			
7	1,003.8	Apr. 25, 28	17.2	18.1	19.0	−1.8			
6	1,008.3	Apr. 25–28, 30, May 3.	16.4	17.4	18.0	−1.6			
5	1,013.0	Apr. 27–28, May 3.	16.5	16.9	17.8	−1.3			
4	1,019.0	Apr. 27, May 5.	15.3	15.9	16.9	−1.6			
3	1,023.8		15.5	15.5	16.7	−1.2			
2	1,029.0	May 1–2	14.5	14.8	15.8	−1.3			
1	1,034.0	Apr. 25	13.6	14.0	14.7	−1.1			
Fort Jackson	1,039.0	Apr. 25–26	13.3	13.3	14.1	−.8	7.16	1903	8.00
A	1,045.3	Apr. 30	12.6						
B	1,049.5	Apr. 25	12.6						
C	1,055.8								

TABLE No. 3.—*Highest gauge readings in 1904 (to June 30) at stations on the Mississippi River above Cairo and on the tributaries of the Mississippi River.*

Station.	River.	Date, 1904.	Gauge reading, 1904.	Previous highest.		Difference.
				Gauge reading.	Year.	
			Feet.	*Feet.*		*Feet.*
Aitkin, Minn	Mississippi	Apr. 12	9.80	15.30	1899	— 5.5
Davenport, Iowa	do	Mar. 27	10.90	19.40	1892	— 8.5
Grafton, Ill	do	Apr. 30	24.00	28.70	1903	— 4.7
St. Louis, Mo	do	Apr. 29	33.60	38.00	1903	— 4.4
Chester, Ill	do	Apr. 30	30.40	33.30	1903	— 2.9
Cape Girardeau, Mo	do	May 1	34.10	36.53	1903	— 2.4
Little Rock, Ark	Arkansas	June 11-12	29.40	31.20	1892	— 1.8
Barbre Landing, La	Atchafalaya	May 2-3	41.25	50.95	1897	— 9.7
West Melville, La	do	May 2-4	34.30	38.70	1903	— 4.4
Nashville, Tenn	Cumberland	Mar. 27	37.62	55.30	1882	—17.7
Hermann, Mo	Missouri	Apr. 27	23.70	29.50	1903	— 5.8
Cincinnati, Ohio	Ohio	Mar. 9	45.90	71.06	1884	—25.2
Louisville, Ky. (upper)	do	Mar. 28	22.90	46.60	1884	—23.7
Louisville, Ky. (lower)	do	do	48.50	72.00	1884	—23.5
Paducah, Ky	do	Apr. 4	44.70	54.25	1884	— 9.6
Camden, Ark	Ouachita	June 12	35.20	46.00	1882	—10.8
Riverton, La	do	Apr. 21-22	36.65	51.90	1892	—15.2
Monroe, La	do	Apr. 16	29.90	48.60	1882	—18.7
Black River Station, La	do	May 7	41.63	54.80	1893	—13.2
Fulton, Ark	Red	June 13-14	31.60	35.75	1876	— 4.2
Shreveport, La	do	June 23-25	28.50	35.70	1892	— 7.2
Alexandria, La	do	June 30	29.50	38.25	1892	— 8.8
Bridge St. Louis, Iron Mountain and Southern R. R.	St. Francis	June 25-26	23.10	41.60	1897	—18.5
Chattanooga, Tenn	Tennessee	Mar. 25	22.10	54.00	1875	—31.9
Florence, Ala	do	Mar. 27-28	17.20	32.20	1897	—15.0
Mount Carmel, Ill	Wabash	Apr. 2	27.10	28.30	1875	— 1.2
Jacksonport, Ark	White	Mar. 29	29.60	33.35	1890	— 3.8
Clarendon, Ark	do	Apr. 8	29.60	36.63	1890	— 7.0
Yazoo City, Miss	Yazoo	Apr. 26-29	22.60	36.50	1882	-13.9

TABLE No. 4.—*Results of discharge observations, Grafton, Ill.*

MISSISSIPPI RIVER—GRAFTON, ILL. (2 MILES BELOW MOUTH OF ILLINOIS RIVER).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
	Weather Bureau.	Local.	Change in 24 hours.	Area.		Depth.			Width.							
				Water.	Below datum.	Mean.	Mean datum.	Maximum.								
1908.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
Nov. 19 a	8.5	3.52	−0.6	46,070	46,070	14.2	14.2	27.7	3,250	....	2.11	97,076	M.	b 14	64	XII, light.
Nov. 21 c	8.0	3.06	− .2	45,194	46,690	13.9	14.4	26.2	3,250	+620	2.06	93,070	M.	d 16	61	Do.
MISSISSIPPI RIVER—ISLAND 521 (ABOVE MOUTH OF ILLINOIS RIVER). (Given separately for each side of island.)																
Nov. 23:																
Right bank	7.6	1.49	−0.2	15,954	15,954	9.9	9.9	14.6	1,617	....	1.75	27,978	M.	9	59	I, light.
Left bank	7.6	1.49	− .2	16,639	16,639	11.3	11.3	17.8	1,470	....	2.08	34,650	M.	8	35	Do.
Total and mean	....	....	....	32,593	32,593	10.6	10.6	....	3,087	....	1.92	62,628	M.	17	94	
Nov. 24:																
Right bank	7.4	1.26	− .2	15,511	15,883	9.6	9.8	14.2	1,617	− 71	1.70	26,379	M.	9	48	Calm.
Left bank	7.4	1.26	− .2	15,951	16,289	10.8	11.1	16.5	1,470	−350	2.04	32,583	M.	9	42	Do.
Total and mean	....	....	....	31,462	32,172	10.2	10.4	....	3,087	−421	1.87	58,962	....	18	90	
Haskell ¼ and Price 22.																
ILLINOIS RIVER—BAXTERS FERRY (1¼ MILES ABOVE MOUTH).																
Nov. 14	9.6	4.90	−0.3	15,339	15,339	16.8	16.8	24.2	912	....	....	....	....	....	27	
Nov. 18 e	9.1	4.00	− .1	14,586	15,405	16.0	16.9	22.4	910	+ 66	0.75	10,907	M.	5	45	XII, light.
Nov. 22 e	7.8	3.00	− .2	12,843	14,557	14.4	16.3	20.2	892	−848	.85	10,855	M.	f 7	24	Calm.
Nov. 22 g	7.8	3.00	− .2	12,843	14,557	14.4	16.3	20.2	892	....	1.00	12,800	M.	f 7	24	Do.

[a] Haskell meter ¼.
[b] Six interpolated from November 21.
[c] Haskell ¼ and Price meters.
[d] One interpolated from November 19.
[e] Haskell ¼.
[f] One interpolated from November 18.
[g] Price 22.

Gauges.—The readings of the Grafton gauge as reported by the Weather Bureau are tabulated; the zero is 424.09 feet above the Cairo datum. The zero of the local gauge on the Illinois River is 429.12 feet and that of the gauge at Island 521 is 432.45 feet, all referred to the Cairo datum.

Observations made under direction of Capt. Wm. B. Ladue, Corps of Engineers, United States Army, secretary of the Mississippi River Commission. Assistant Engineer W. G. Comber, chief of party; M. A. Bell, observer.

TABLE No. 4.—*Results of discharge observations, Cumberland River.*

ROCKCASTLE, KY.

Date.	Local gauge.	Change in 24 hours.	Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
			Area.		Depth.										
			Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.							
1903.	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
Sept. 21	0.96	−0.04	3,156	3,156	7.4	7.4	9.0	429	....	0.46	1,465	H. M.	6	24	Calm.
Do.	.96	....	3,197	3,197	7.4	7.4	9.5	429	+41	.45	1,429	H. M.	6	18	Do.
Do[a]	.96	....	3,168	3,168	7.4	7.4	9.4	429	−29	.44	1,397	H. M.	5	19	VI, light.
Do[a]	.96	....	3,243	3,243	7.6	7.6	9.3	429	+75	.46	1,498	H. M.	5	19	Do.
Sept. 22	.95	−.01	3,234	3,238	7.5	7.6	9.5	429	− 5	.43	1,400	H. M.	5	19	Calm.
Do.	.95	....	3,254	3,259	7.6	7.6	9.5	429	+21	.45	1,477	H. M.	11	18	Do.
Do[a]	.95	....	....	....	....	....	....	....	....	.46	1,509	R. F.	5	18	Do.
Sept. 23	.92	−.03	3,330	3,347	7.8	7.8	9.5	429	+88	.46	1,546	R. F.	10	18	Do.
Do.	.92	....	....	....	....	....	....	....	....	.43	1,420	R. F.	5	18	VI, light.
Sept. 25	.85	−.04	3,244	3,292	7.6	7.7	9.5	429	−55	.46	1,484	P. M.	16	19	Calm.
Do[a]	.85	....	....	....	....	....	....	....	....	.48	1,552	D. F.	10	19	XII, light.
Sept. 26	.81	−.04	3,261	3,325	7.6	7.8	9.4	429	+83	.46	1,512	P. M.	11	22	Do.
Do[a]	.81	....	....	....	....	....	....	....	....	.49	1,594	D. F.	5	22	Do.
Sept. 30	.70	−.05	3,243	3,354	7.6	7.8	9.3	429	+29	.48	1,574	P. M.	11	18	Do.
Oct. 2	.72	+.03	3,176	3,278	7.4	7.6	9.8	429	−76	.45	1,433	D. F.	11	19	Calm.
Do[a]	.72	....	3,235	3,238	7.5	7.8	9.0	429	+60	.44	[b]1,428	P. M.	5	19	Do.

[a] Observations made in P. M. All other observations were made in A. M.

[b] Velocities partly interpolated.

Gauges—Elevation of local gauge with reference to Cairo datum not yet determined. The U. S. Engineer gauge on the Cumberland River at Nashville, Tenn., ranged from 1.2 feet on Sept. 21 to 0.9 foot on Oct. 2.

In the column marked "Method," H. M. denotes Haskell meter ¼, P. M. denotes Price meter 34, D. F. denotes double floats, and R. F. denotes rod floats.

The meters were run at six-tenths depth.

The floats were run at mid depth.

Velocities obtained by rod floats were reduced to mean velocity by using the coefficient 0.93 derived from Francis formula.

Discharge section is 1 mile below Rockcastle, Ky., 53 miles above mouth.

TABLE No. 4.—*Results of discharge observations, Tennessee River.*

BIRMINGHAM, KY.

Date.	Local gauge.	Change in 24 hours.	Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
			Area.		Depth.			Width.							
			Water.	Below datum.	Mean.	Mean datum.	Maximum.								
1903.	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
September 5	0.92	−0.10	11,344	11,344	8.7	8.7	13.9	1,299		1.25	14,143	H. M.	11	43	VI, light to brisk.
Do.										1.15	13,025	P. M.	11		
Do.[a]	.92	− .10	11,567	11,567	8.9	8.9	13.5	1,299	+223	1.22	14,161	H. M.	9	36	V, brisk.
September 6	.90	− .02	11,142	11,168	8.6	8.6	12.9	1,299	−399	1.19	13,289	H. M.	11	39	Calm.
Do.[a]	.90	− .02	11,242	11,268	8.6	8.7	13.9	1,299	+100	1.24	14,001	H. M.	12	40	Calm to VI, light.
Do.[a]										1.16	13,031	P. M.	12		
September 7	.90	.00	11,469	11,495	8.8	8.8	13.9	1,299	+227	1.19	13,638	H. M.	12	44	XII, light.
Do.										1.19	13,664	P. M.	12		
Do.	.90	.00	11,174	11,200	8.6	8.6	13.1	1,299	−295	1.20	13,385	H. M.	11	44	XII, light.
Do.										1.18	13,173	P. M.	11		
Do.[a]	.90	.00	11,362	11,388	8.8	8.8	13.2	1,299	+188	1.18	13,420	H. M.	11	49	XII, brisk.
Do.[a]										1.21	13,785	P. M.	11		
September 8	.86	− .04	10,883	10,961	8.4	8.4	12.9	1,299	−427	1.21	13,201	H. M.	11	47	XII, light.
Do.										1.22	13,334	P. M.	11		
Do.[a]	.86	− .04	11,044	11,122	8.5	8.6	13.0	1,299	+161	1.22	13,414	H. M.	11	44	XII, light.
Do.[a]										1.26	13,880	P. M.	11		
September 9	.80	− .06	10,909	11,065	8.4	8.5	12.9	1,299	− 57	1.14	12,488	H. M.	11	47	Calm.
Do.										1.18	12,886	P. M.	11		
Do.[a]	.80	− .06	10,999	11,155	8.5	8.6	12.9	1,299	+ 90	1.15	12,651	H. M.	11	45	XII, light.
Do.[a]										1.20	13,161	P. M.	11		
September 10	.71	− .09	10,654	10,927	8.2	8.4	13.0	1,299	−228	1.17	12,448	H. M.	11	47	Calm to XII, light.
Do.										1.20	12,824	P. M.	11		
September 11	.68	− .03	10,673	10,985	8.2	8.5	12.5	1,299	+ 58	1.11	11,894	H. M.	12	42	Calm to XII, brisk.
Do.										1.13	12,071	P. M.	12		
Do.[a]	.68	− .03	10,486	10,798	8.1	8.3	12.3	1,299	−187	1.12	11,753	H. M.	11	36	Calm.
Do.[a]										1.17	12,258	P. M.	11		
September 12	.62	− .06	11,261	11,650	8.7	9.0	13.3	1,299	+852	1.14	12,872	H. M.	12	42	XII, light to brisk.
Do.										1.21	13,652	P. M.	12		
Do.[a]	.62	− .06	11,108	11,498	8.6	8.8	13.4	1,299	−152	1.15	12,819	H. M.	11	36	XII, brisk.
Do.[a]										1.20	13,321	P. M.	11		

[a] Observations made in P. M. All other observations were made in A. M.

TABLE No. 4.—*Results of discharge observations, Tennessee River*—Continued.

BIRMINGHAM, KY.—Continued.

Date.	Local gauge.	Change in 24 hours.	Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
			Area.		Depth.			Width.							
			Water.	Below datum.	Mean.	Mean datum.	Maximum.								
1903.	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
Sept. 14	0.51	−0.03	11,074	11,607	8.5	8.9	13.1	1,299	+109	1.08	11,923	H. M.	11	41	Calm to XII, light.
Do										1.12	12,450	P. M.	11		
Do. [a]	.51	− .03	11,097	11,630	8.5	9.0	12.8	1,299	+ 23	1.05	11,638	H. M.	11	40	XII, light.
Do. [a]										1.09	12,107	P. M.	11		
Sept. 15	.49	− .02	10,850	11,408	8.4	8.8	13.2	1,299	−222	1.07	11,564	H. M.	11	42	Calm.
Do										1.14	12,376	P. M.	11		
Sept. 16	.48	− .01	10,735	11,306	8.3	8.7	12.9	1,299	−102	.98	10,557	H. M.	11	40	VI, brisk.
Do										1.06	11,377	P. M.	11		
Sept. 18	.34	− .07	10,598	11,351	8.2	8.7	12.4	1,299	+ 45	.98	10,359	H. M.	11	42	Calm.
Do. [a]	.34	− .07	10,846	11,600	8.4	8.9	12.6	1,299	+249	.95	10,347	H. M.	11	37	Do.
Sept. 19	.35	+ .01	10,680	11,420	8.2	8.8	12.4	1,299	−180	1.01	10,790	H. M.	10	42	Do.

[a] Observations made in P. M. All other observations made in A. M.

Gauges.—Elevation of local gauge with reference to Cairo datum not yet determined. The U. S. Engineer gauge on the Tennessee River at Florence, Ala., ranged from 0.0 foot on September 5 to −0.2 foot on September 19.

In the column marked "Method" H. M. denotes Haskell meter ¼ and P. M. denotes Price meter 34. Results inclosed in braces are from simultaneous observations with 2 meters. The meters were run at six-tenths depth.

Discharge section is 1¼ miles below Birmingham, Ky., 26 miles above mouth.

TABLE NO. 5.—*Meter ratings.*

HASKELL METERS.

Number of wheel.	Frame.	Date, 1903.	A.	B.	Number of observations.	Length of base.	Limits of observed velocity per second.	Locality.
						Feet.	*Feet.*	
1	A	August 20, 21	1.54076	+0.25263	46	200	0.3 to 3.2	St. Louis, Mo.
1	A	.....do	1.68023	+ .01127	30	200	3.1 to 12.4	Do.
1	A	August 18, 19	1.52661	+ .25427	20	200	.4 to 2.7	Do.
1	A	September 27–29	1.71739	+ .13093	32	200	.4 to 2.5	Rock Castle, Ky.
1	A	.....do	1.87439	+ .29348	14	200	.6 to 1.1	Do.
1	B	August 20, 21	1.28018	+ .08479	86	200	.6 to 14.1	St. Louis, Mo.
2	A	August 24, 25	1.75117	+ .17220	42	200	.6 to 5.8	Do.
6	A	August 22	1.19164	+ .03611	60	200	1.1 to 11.3	Do.
10	B	.....do	2.18882	− .05218	60	200	1.2 to 11.3	Do.
11	B	August 18, 19	2.08259	− .16156	24	200	3.3 to 10.8	Do.
11	B	.....do	1.81242	+ .42121	26	200	1.1 to 5.1	Do.
1	A	August 28, 29	1.63290	+ .16887	14	200	.3 to 1.1	Rock Castle, Ky.
1	A	December 4	1.78393	+ .15392	15	200	.5 to 3.7	St. Louis, Mo.

PRICE METERS.

Number of meter.	Frame.	Date, 1903.	A.	B.	Number of observations.	Length of base.	Limits of observed velocity per second.	Locality.
						Feet.	*Feet.*	
22	....	August 18, 19	3.84331	+0.31349	62	200	0.4 to 8.5	St. Louis, Mo.
23	....	August 20, 21	4.09833	+ .16799	74	200	.2 to 7.1	Do.
25	....	August 22	3.90100	+ .27789	66	200	.6 to 11.3	Do.
29	....	August 24, 25	3.88624	+ .21001	62	200	.4 to 10.6	Do.
34	....	August 20, 21	4.14548	+ .05632	62	200	.3 to 5.6	Do.
34	....	August 22	4.02650	+ .12694	52	200	.8 to 6.0	Do.
34	....	August 24, 25	4.03108	+ .05064	50	200	.4 to 5.8	Do.
34	....	September 28, 29	3.12835	+ .18822	16	200	.4 to .9	Rock Castle, Ky.
34	....	.....do	4.07877	+ .01966	44	200	.3 to 2.5	Do.
43	....	August 18, 19	3.96546	+ .19250	78	200	.4 to 9.5	St. Louis, Mo.
38	....	May 4	4.47620	+ .04509	10	200	.8 to 2.2	Huntington, Miss.
22	....	December 4	4.03210	+ .23961	9	200	.5 to 2.7	St. Louis, Mo.

APPENDIX 1 C.

REPORT OF MR. F. B. MALTBY, ASSISTANT ENGINEER, UPON DREDGING OPERATIONS ON THE MISSISSIPPI RIVER BETWEEN HEAD OF THE PASSES AND THE MOUTH OF THE OHIO RIVER, AND CARE AND REPAIR OF DREDGING PLANT, APRIL 1, 1903, TO MARCH 31, 1904.

MEMPHIS, TENN., *April 27, 1904.*

CAPTAIN: I have the honor to submit the following report pertaining to the care and repair of dredging plant and dredging operations, under my direction, for the period April 1, 1903, to March 31, 1904.

The project for maintaining a low-water channel through troublesome bars by means of dredging has been fully explained in previous reports.

CARE OF PLANT.

During the year the following plant, when not in operation, has been cared for at West Memphis, Ark.:

Dredges: *Beta*, *Gamma*, *Delta*, *Epsilon*, *Zeta*, *Iota*, *Kappa*, and *Henry Flad*	8
Steamboats: *Mississippi*, *Minnetonka*, *Sachem*, *Choctaw*, *Nokomis*, *Wynoka*, *Leota*, *Search*, *Patrol*, *Vulcan*, *Venus*, *Mercury*, and *Mars*	13
Pile sinkers: Nos. *61*, *971*, *981*, *982*, *983*, and *984*	6
Barges: Nos. *208*, *211*, *215*, and *228*	4
Quarterboat: *Illinois*	1
Small flush-deck flat	1
Calking flat	1

Quarterboats Nos. *13* and *154* are blocked up on shore and are being used as storehouses.

The small steam tender *Venus* or *Vulcan* has been used as fleet tender during the lay-up season.

The steamer *Mississippi*, used exclusively as an inspection boat by the Mississippi River Commission, was on the way up the river at the beginning of the period and reached the fleet April 7, and was laid up. She left the fleet July 23 for Louisville, where she received a general repairing. She returned to the fleet, after completing the regular fall inspection trip, on November 27. Owing to the fact that at the time no other towboats were available, she was sent to Cairo for two barges of coal during the first week in January, 1904. She again left the fleet, for the spring inspection trip, March 2, 1904, and returned on the 25th.

The steamer *Patrol* (surveys, gauges, and observations) reached the fleet June 20, 1903. She was used in making one inspection trip in connection with dredging operations, from Memphis to Point Pleasant, August 8 to 11; and again left the fleet, towing the quarterboat *Illinois*, for work connected with surveys, gauges, and observations, September 16, 1903, and returned to the fleet March 16, 1904, where she was laid up.

During the year the following boats belonging to the dredging plant have been used on other work, as stated:

Steamers *Mars* and *Mercury* were on duty in connection with levee supply work from April 1 to 10, 1903.

Steamer *Mars* was on duty in connection with work of surveys, gauges, and observations from September 16 to December, 23, 1903; and again left the fleet March 31, 1904, for discharge observation work.

Steamer *Venus* was on duty from April 1, 1903, to April 21, 1903, on discharge work.

Steamer *Nokomis* was loaned to the Light-house Department from December 3, 1903, to January 29, 1904.

At the beginning of the period covered by this report the dredge *Beta* and steamer *Sachem*, with the necessary accompanying plant, were at South Pass on duty connected with that work. This plant was returned to the fleet September 28, 1903.

About the middle of June a party was sent to Stewarts Landing to care for the season's supply of fuel. On June 25 ten barges, all that had then been received, were moved by the steamer *Leota* to Caruthersville, Mo., and the coal fleet was maintained at that point during the season till December 1, when the coal remaining on hand was taken to the fleet at West Memphis.

The steamer *Wynoka*, in tow of the steamer *Leota*, arrived from Jeffersonville, Ind., July 2, 1903.

Miscellaneous.—The general work of care of plant at the fleet consists in arranging and keeping the plant in position, cleaning hulls, bringing supplies and material from the wharf at Memphis, checking, assorting, and caring for property, and general office work.

SUBSISTENCE.

All employees are furnished subsistence in kind. During the year 71,981 rations were served, at a cost of $0.499 each, including the cost of cooks, waiters, and the necessary labor in caring for quarters.

REPAIRS TO PLANT.

In addition to the more important items of repairs mentioned below in connection with each piece of plant, general minor repairs, such as grinding valves, repacking steam-pipe joints, painting smokestacks, small repairs to woodwork, and tightening up propelling wheels, were made where necessary. The boilers on all boats were also inspected and tested in the same manner as provided by the United States steamboat inspection laws.

The aggregate amount of this class of work is quite a large item of cost.

Dredge Beta.—New stacks have been built in place. New tubes for the feed-water heater have been procured. The floating discharge pipes were found to be badly worn on the bottom, due to the action of the sand carried through them; the pipes were turned over in the pontons so that the worn portions would come on top; the end rings of each section of pipe were cut off and renewed with new iron. The pontons have been partly sandblasted and painted. New screens have been put in the feed-water filters. The furnaces have been rebuilt. The roof has been repaired and painted and the cabin painted on the inside. To fit the dredge for work at South Pass the suction head has been lengthened 6 feet, which will permit dredging to a depth of 36 feet below the water surface. This work has been paid for by the officer in charge of the improvement of South Pass.

Dredge Gamma.—This dredge was not in commission during the year, and the only repairs made were minor repairs to woodwork and painting.

Dredge Delta.—Additional supports for the foundation of the main engines were put in. The engines operating the hoisting and hauling machinery were made reversing, in order to permit of a better control of the hauling machinery when dredging downstream; this necessitated making new clutches for this machinery. A new suction tank or well for supplying water to the condenser and boiler feed pumps was built in the hold. Screen bars were put over the opening in the suction head used when dredging downstream. New edge plates were put on the main pump runner. The main engine was thoroughly overhauled, lined up, and new piston rings made. Towing knees were placed on the forward deck. One new tube was put in the boilers and the feed pumps were repaired. The woodwork around the ice box and kitchen sink was repaired and a new floor was laid in the crew's quarters and in the dining room.

The suction pipes for the jet pumps are being moved to take water farther aft, where it is hoped that less sand will be taken up with the water and thus decrease the wear of the valves and plungers of these pumps. The furnaces have been repaired.

Dredge Epsilon.—Minor repairs were made to the domestic water-supply system, and a new tank was made and put on the roof. The outside of the cabin was partly painted.

Dredge Zeta.—A new water tank for the roof was made, the domestic water-supply system was overhauled, and the roof and part of the cabin on the outside painted. Steam-pipe covering was repaired. The runner in the main pump (7-bladed) is being converted into one of the closed type.

Dredge Iota.—The main pump casing was bored out and a shroud was fitted to the runner, converting it into one of the closed type. The water end of the jet condenser was bored out. A traveling crane was made and installed over the main pumps and engines. The winding engines were moved to line up with the fair-lead sheaves. The tiller rope was spliced. New valves were placed in the main steam line. A new feed-water heater was installed. The cabin was painted inside and out. New crosshead brasses for the main pumping engines were made.

Dredge Kappa.—New stop valves were put in the main steam line. New fire-door liners were made. The ice plant was thoroughly overhauled. The cabin was painted on the outside. The universal couplings of the discharge-pipe line were repaired. The arc lights on the main deck were replaced with incandescent lamps. A new feed-water heater was installed. A new high-pressure cylinder for the main pumping engine was purchased from the builders in the rough. The machine work was done in Memphis, and it was installed at the fleet. A new connecting rod, valve rods, and low-pressure slide valve were made. The engine was lined throughout very carefully. The boiler-feed pumps were overhauled. The shrouds on the sand pump have been set out about one-quarter inch to decrease the clearance caused by wear. The feed-water pipes have been renewed. Fire was discovered under the pilot house on January 29, 1904, but was promptly extinguished. The resulting damage, consisting of broken glass and bulkheads, has been repaired. Some of the deck hatches are being enlarged and coamings placed around them. Small additional hatches for ventitlation have been cut. A drain tank, with a vent pipe extending above the roof, has been placed in the hold, and all drain pipes from engines and pumps and heating system will be run into it.

Dredge Henry Flad.—The high-pressure cylinder of the port pumping engine was bored out and a new piston made for it. New fire-door liners were made. The arc lights on the main deck were replaced by incandescent lamps. Repairs were made to the universal couplings of the discharge-pipe line. The condensed-water system in connection with the ice plant was placed on the roof. The insides of the wheel-houses were painted with coal tar. A new feed-water heater was installed. New stop valves were put in the main steam line. Traveling cranes were built and installed over the main pump and engines. The shrouds on the sand-pump runner were set out one-quarter inch to decrease the clearance caused by wear. A crack in the hot well has been patched. Some deck hatches have been enlarged; additional small ones have been cut for ventilation, and iron coamings placed around all of them. A drain tank, with a vent leading above the roof, has been placed in the hold, and all drains from pumps and engines will lead into this.

Steamer Mississippi (*Mississippi River Commission*).—The capstan engines and the doctor were thoroughly overhauled. A considerable amount of repairing was done to steam and water pipes, all of which are becoming old. The roof was repaired. A new lavatory was put in and connected up.

Steamer Minnetonka.—This boat is unserviceable and has not been in commission, and only such slight repairs have been made as were necessary to keep her in a safe condition.

Steamer Sachem.—The boilers on this boat, as well as on the others of the same type, have given considerable trouble by the shearing of the rivets of the vertical seam. The boilers are about 30 feet long, and were originally in two sheets longitudinally. It was thought that these long sheets carried an excessive amount of contraction and expansion to this single seam, and to counteract this effect pieces about 24 inches long were cut out near the center of each sheet and new sheets put in, making five vertical seams instead of one. This work is now completed on all the boats of this class.

The Samson posts and braces over the cylinder timbers have been extended to the roof. A new roof has been put on. The cylinders of both main propelling engines have been bored out and new packing rings have been made. New copper gaskets have been put under the side-pipe joints all around. The feed-water pumps have been moved into the engine room, the suction shoes changed, and new feed-water heaters have been made and installed. The furnaces have been rebuilt throughout. Coamings have been placed around hatch openings, projecting above the deck to prevent water, etc., from getting into the hold. The nosing has been repaired.

Steamer Choctaw.—The work of repairing the boilers, as mentioned above, was completed. New stop valves have been put in the main steam line. The furnaces have been rebuilt. New stacks were erected. The boiler deck was covered with canvas and painted. The boiler feed pumps have been moved into the engine room. New feed-water heaters are being built. The boat was painted all over on the outside. The hull has been thoroughly scraped and painted on the inside. A new asbestos roof has been put on. A new wheel has been built.

Steamer Nokomis.—Repairs to the boilers, as mentioned above, were made. The furnaces were rebuilt. A new wheel has been built. The cylinder of the port main propelling engine was bored out and new packing rings were made. New stop valves have been put in the main steam line. New stacks were erected. The Samson posts and chain braces for supporting the cylinder timbers were extended to the roof. The boiler feed pumps have been moved into the engine room. Small cranes for handling the cylinder heads of the main engines have been made.

Steamer Wynoka.—A new cabin was built on this boat at Jeffersonville, Ind., and she was received at the fleet July 2, 1903. All the work of installing and erecting the machinery, pipes, and fittings was done at the fleet. The cylinder of the starboard main propelling engine has been bored out, and new packing rings have been made. New feed-water heaters are being built.

Steamer Leota.—New stacks have been erected. The feed-water pumps have been moved to the engine room, and the suction shoes and suction pipes leading to them have been moved. New feed-water heaters have been built and erected. Coamings have been placed around the deck openings to prevent water running into the hold. The boiler deck was covered with canvas and painted. The furnaces were rebuilt. A new wheel has been built. The ice machine was thoroughly overhauled. A new steering engine has been purchased and installed.

Steamer Search.—The hull, which is of wood, was entirely rebuilt. The boat was painted inside and out. General minor repairs were made to the engines and steam piping. New steel cylinder timbers have been procured and are being put in position.

Steamer Patrol (surveys, guages, and observations).—Only general minor repairs have been made to the woodwork and to the machinery.

Steamer Vulcan.—Minor repairs only have been made to the engines and to the woodwork where necessary.

Steamer Venus.—The deck has been repaired. New stanchions have been put in where required. A new stack has been built. The boat has been painted inside and out. The roof has been repaired.

Steamer Mercury.—Extensive repairs have been made to the nosing and deck. New stanchions have been put in where necessary. A new wheel has been built. The boat has been painted inside and out. A new ash pan has been built.

Steamer Mars.—Only slight general repairs to the woodwork have been made where necessary.

Pile sinkers.—Pile sinker *No. 971* was placed in dry dock, the hull thoroughly repaired and renewed where necessary, a new set of leads throughout was built, and the pile sinker given a thorough overhauling.

Pile sinker *No. 983* was placed in dry dock, the hull thoroughly repaired and rebuilt where necessary, and calked throughout. The cabin and deck have been painted.

Only such repairs have been made to the other pile sinkers and barges as have been necessary to keep them in a serviceable condition.

DREDGING OPERATIONS.

The season of 1903 did not develop a stage in the river below Cairo which required extensive dredging until about December 5. A part of the dredges, however, were placed in commission as early as August, 1903, as the indications at that time were that dredging would soon be required, and all of them except the *Gamma* were in commission during the early part of September. They were held in the field and did such dredging as seemed desirable until the latter part of November. At this time the river at Cairo stood at a stage of about 11 feet on the gauge, and at that time there was not less than a 10-foot steamboat channel from Cairo south. A rise approximating 7 feet had just crested at Evansville, and it was thought that this would make a rise of at least 3 or 4 feet at Cairo, and that probably before the river at Cairo again reached a stage which would require dredging it would be followed by an additional rise, as is ordinarily the case at this time of the year. With this idea in mind all of the dredges had been sent to the fleet at West Memphis, Ark., and, with the exception of the *Delta*, *Iota*, and *Flad*, had been put out of commission.

Contrary to this expectation, the river, instead of rising, remained at a stage of between 10 and 11 feet, the only effect of the upper Ohio River rise apparently being to check the fall, and about December 3 it began to fall very rapidly and by December 20 had fallen 9.1 feet, an average of slightly over 6 inches per day. This very rapid and unexpected fall produced unexpected conditions and made necessary, in order to maintain fully the project, a larger amount of dredging than we were able to do in the available time, and during a period of possibly ten days or two weeks a channel 9 feet in depth was not maintained. This failure to maintain the channel as contemplated was not due to any lack of capacity of the dredges to perform the necessary work. It was due to an error in judgment in retiring the dredges from the field and to a shortage of coal, which prevented full use of such dredges as were available. That we were not alone in our prediction of the probable stage of the river is evidenced by the fact that the Consolidated Coal Company started two large tows of coal from Evansville on the crest of this rise and both were grounded a short distance above Paducah.

The shortage of coal was caused, first, by the same error in predicting the probable amount of dredging that would be required, and second, that we lost, by accident, practically two loaded barges just at the time when the coal was most urgently needed.

In spite of the fact that the channel was not fully maintained, as mentioned above, I know of no steamboats which were aground when in the channel, due to the depth of water. The weather at this time was particularly severe, and navigation was practically suspended on this account.

The following is a description of the work done by the dredges and at each locality:

Dredge Beta.—This dredge was not in commission on work under the direction of this office during the year.

Dredge Gamma.—This dredge was not placed in commission during the season.

Dredge Delta.—This dredge, in tow of the steamer *Wynoka*, left the fleet at noon August 27, 1903, for Peters Crossing (270), arriving there at 6.30 p. m. of the same day. This crossing at this time showed the shoalest water below Cairo, there being not over 9½ feet in the channel, and surveys showing that the bottom was 4 feet and over above standard low water for a distance of one-half mile up and down stream and for the full width of the river. The stage at this time was about 14 feet above standard low water.

Dredging was commenced at 6.40 a. m., August 30, and continued until 4.25 p. m. of the same day, when it was found that one of the edge plates of the main sand-pump runner was broken. This was replaced by a new one and dredging was resumed at 5.25 a. m., August 31. Work continued, with only slight interruptions due to adjusting main engines, cleaning suction pipe of drift, etc., until September 6, when about six hours were lost on account of the blowing out of a steam joint, which necessitated cooling down the boilers. A further interruption of about eight hours occurred on the 8th, owing to the steam valve in the high-pressure cylinder of the main engine becoming loose. Dredging was discontinued on the 9th. Surveys of September 5 show in a very striking manner the effective work of the dredge. A channel from 7 to 9 feet greater in depth than existed when dredging was commenced was shown along the axis of the cut.

Dredging was resumed at the same point on September 28, and on this day, as well as the next, was done during daylight watch only, on account of scarcity of labor. On the 30th work was begun with a double crew. A survey made just before dredging was begun the second time shows the cut previously made to be in good condition as a whole. The bar as a whole also remained in about the same condition as before the rise which had taken place between the times dredging was done. Dredging was continued without interruption and with a loss of time of only fifteen minutes, until the completion of the work contemplated, at 10.30 a. m., October 5. The results were most satisfactory. There was a good, straight steamboat channel not less than 16 feet in depth and of ample width, while over the bar outside of the cut there was only 9 feet. At this time the stage at Memphis was still about 9 feet above standard low water. No further dredging was done at this point during the season, and the channel continued to improve steadily, and even during the extreme low water in December there was not less than 8 feet over the bar, and this at a single point only, just at the head of the dredged cut. At the time the last examination was made, which was at a stage of about 4 feet above standard low water, there was not less than 12 feet in the channel, while near the lower end of the cut there was at least 24 feet of water.

The dredge, in tow of the steamer *Wynoka*, left Peters Crossing, upstream, at 2.30 p. m., October 5, arriving at the head of Presidents Island (234) October 8, where dredging was commenced on the same day and continued, with slight delays for cleaning suction and repairing hauling cables, until October 14, when dredging was suspended, owing to a rising river. The dredging done at this point, as has been the case in previous years, was a most difficult and expensive operation, due to the material encountered. The obstructing bar seems to be composed of a very coarse gravel. It is extremely difficult to move with a hydraulic dredge and is particularly severe on the pump and all of the machinery.

The dredge lay at the bank until November 4, when dredging was resumed at the same bar at 2.45 p. m. Owing to the difficulty in dredging this gravel and to certain indications that the channel might be maintained lower down over the reef, the second dredging was done somewhat farther downstream and less gravel was encountered. Work was continued, with slight interruptions for cleaning the suction and repairing broken hauling cables, until November 11, when a piston rod of the port jet pump was broken. This was repaired the next day. Dredging was not suspended during the interval, but progress was somewhat slower, as the jet pump could not be operated. November 14 it was found that the packing rings on the high-pressure piston of the main engine was broken. These were replaced with new ones. At the same time new edge plates for the runner of the main pump were put in place. As a considerable amount of time had been lost, due to the breaking of the port hauling cable, it was replaced with one taken from the dredge *Zeta*. The work at this bar was completed at noon November 17, when 15 cuts had been made. At this time there was a good 16-foot steamboat channel about 250 feet in width, and the dredge was taken to the fleet. The channel at this time was well defined.

The dredge again left the fleet, in tow of the steamers *Wynoka* and *Choctaw*, at 7.15 a. m., December 14, and arrived at Random Shot Crossing (192) at 9.45 a. m., December 15. Dredging was begun at 2.15 p. m. of the same day and continued without serious delay until 6 a. m. of the 18th, when the work was completed. There was then a good 12-foot steamboat channel not less than 250 feet in width. The work done at this crossing presents one of the best examples of quick and efficient dredging of any done during the season. The time properly chargeable to dredging operations at this bar was sixty-eight hours, divided as follows:

	Hours.
Placing plant	4½
Changing cuts	3½
Repairing	1
Dredging	59

During this time six cuts were made, having a total length of 4,440 feet and an average depth of 8 feet. The least depth over the bar where the dredging was done was not over 5½ feet, although there was a possible channel of about 7 feet over the bar before dredging.

Tow was made up and the dredge started upstream at 3.45 p. m., December 18, arriving at the head of Island 21 (131) on the 21st. Dredging was begun at 12.20 p. m., December 22, and continued without serious interruption until 7 a. m. of the 24th. At this time six cuts had been completed and there was a good 12-foot channel over the crossing.

The dredge left, upstream, at 10.40 a. m., December 24, and owing to delays on account of severe weather and repairs necessary to the steamboats, she did not reach Darnell's bar (81) until 2.45 p. m., December 27. Dredging was begun at 4.20 a. m. of the 28th and continued, with slight interruptions only, until 12.40 a. m. of the 29th, when three cuts had been completed. The river was then rising rapidly, and as notice had been received that two coal tows desired to pass down, dredging was discontinued. There was then 13 feet over the crossing.

The dredge left, downstream, at 7.20 a. m. of the same day, and tied up at Peacocks Landing at 8.40 a. m., to allow two tows of coal to pass. She arrived at Joe Eckles's bar (93) at 1.40 p. m., but owing to severe weather dredging was not begun until 1.10 p. m., December 30. Work continued until 11 p. m. of the same day, when four cuts had been made, and as there was 15 feet in the channel, dredging was discontinued and the dredge was retired to the fleet at West Memphis, where she arrived December 31 and was laid up.

Dredge Epsilon.—This dredge, in tow of the steamer *Leota*, left the fleet on the morning of September 9 and reached Luxora, Ark. (162), on the morning of the 10th. Owing to the stage of the river, dredging was not begun until 8.20 p. m. of the 13th, and was continued without serious delay until 9.45 a. m. of the 15th, when 17 short cuts had been made. There was then a good 16-foot channel over the bar, and as the river was rising, the dredge went to the bank to await a lower stage. No further dredging was done on this bar during the season. Later in the season the channel went down the shore by New Haven.

On September 29 the dredge was moved to Last Chance (166). Dredging was begun the same day and continued with very little delay until 2.20 p. m., October 2, when it was completed. Twenty-three cuts were made and there was a wide 17-foot channel at that time. No further work was done at this point during the season. The channel remained in the dredged cut, and there was not less than 10 feet during the season.

The dredge left Last Chance Crossing October 2, arriving at Gold Dust Crossing (158) at 10 a. m. of the 3d. Dredging was begun at 2 p. m. of the same day and continued until 7.10 a. m. of the 6th, when the work was completed. Fifteen cuts were made and only one-half hour was lost for repairs. There was at the time a 16-foot channel over the bar, but owing to the high stage it was not as well defined as was desirable, and additional dredging was required later in the season.

The dredge went to the bank to await a lower stage of the river, and on October 22 was put out of commission for the season.

Dredge Zeta.—This dredge and outfit, in tow of the steamer *Nokomis*, left the fleet at noon August 14 and reached Joe Eckles bar (93) on the evening of the 18th. Dredging was begun on the 19th and continued until the evening of the 20th, when operations were suspended on account of the desertion of all the firemen. As there was a 16-foot channel the dredge was permitted to remain at the bank until the 29th, when dredging was resumed at 7.45 p. m. and continued until 5.45 a. m. September 2, when the work was completed. Seventeen cuts were made and there was 17 feet in the channel. The dredge was dropped down about one-half mile, to the lower end of the same bar, where there was a short reef, and four cuts were made the same day; the dredge then went to the bank to await a lower stage.

September 15 the dredge was moved to Cherokee Landing (90), where she lay until the 29th, when dredging was begun, with a daylight crew only. The work was completed October 1, after making 10 cuts. There was then 16½ feet of water in the channel, and no further work was done at this crossing during the year, and there was at no time less than 8 feet over the bar.

After cleaning boilers the dredge went to the lower part of Joe Eckles bar, and began dredging at 1.15 p. m. October 2 and continued without interruption until 4 p. m. October 3, when 9 cuts had been completed, having a total length of 5,600 feet. There was then a good 17-foot channel over the bar, and no further dredging was done over this part of the bar during the season, and at no time during the season was there less than 9 feet over it, though the upper and first part dredged was afterwards dredged by the *Delta*.

The dredge remained at the bank, awaiting a lower stage, until October 10, when it was moved to Hathaway (103), where dredging was begun at 7.20 a. m. October 11 and continued, working daylight watch only on account of scarcity of labor, until 1.20 p. m. October 14. Sixteen cuts were made and there was then a good 16-foot channel over the crossing. The dredge remained at the bank, awaiting a lower stage, until October 22, when she was sent to the fleet and put out of commission October 23. Only about one and one-half hours' time was lost by this dredge during the season on account of repairs.

Dredge Iota.—This dredge, under her own steam, left the fleet August 6 and arrived at the head of Deans Island (197) on the 7th, where she waited three days for a barge of coal, which was delivered by the *Nokomis* on the 10th. She left upstream on the morning of the 11th, with 10 pontons, a pile-driver, and coal barge, and with this tow she was unable to make much over a mile an hour. She arrived at Bixbys towhead (83) August 17, having been assisted from Gayoso by the steamer *Leota*. Dredging was begun on the 19th and continued in daylight only, on account of scarcity of labor. Six cuts were completed by the 20th, and dredging was suspended until the morning of the 23d, when it was resumed. On this day five hours were lost by the fouling of the swivel elbow in the discharge pipe at the stern of the dredge. Dredging was suspended on the 25th, owing to a rising river, and the dredge remained at the bank until September 2, when dredging was resumed and continued during daylight watches until the 4th, when work was again suspended on account of the high stage. The dredge lay at the bank until September 29, when dredging was resumed and continued until October 2, when ten and one-half hours were lost in again repairing the reversed elbow in the discharge pipe. Dredging was completed on the 4th and the dredge again went to the bank to await a lower stage. At this time there was 14 feet in the channel.

On October 22 the dredge went to Caruthersville, Mo., for a barge of coal, then went to New Madrid (70), arriving on the 26th. Dredging was begun on the 28th and continued until November 3, when the entire day was consumed in making repairs to a broken frame of the jet pump. At this time an examination showed that an 18-foot channel had developed fully 1½ miles above the channel being dredged, and further work was abandoned as being unnecessary.

November 4, while getting under way, a joint in the main steam pipe blew out, and during the excitement which ensued the spud was dropped and broken off.

The dredge reached Hathaway Crossing (103) November 5, but owing to difficulty in placing the plant by means of anchors, dredging was not begun until the 7th. Work continued, with slight interruptions, until the 14th, and on the 19th she was put out of commission. This dredge worked only during daylight watches during the entire season, owing to scarcity of labor.

The dredge was again placed in commission December 13, by order of the officer in charge, and held in readiness for work until January 3, 1904, but was not able to leave the fleet on account of a shortage of coal.

Dredge Kappa.—This dredge, under her own steam and towing her own pontons only, left the fleet on the morning of August 19, arriving at the head of Island 21 (131) on the 22d. At this time there was not less than 17 feet in the channel at this point, and on the 25th she left Island 21 and arrived at Hathaway (103) on the 26th. Dredging was begun at 12.45 p. m., August 27, and continued, during daylight only, until the 30th, when dredging was completed, and she went to the bank to await a lower stage. At this time there was a good 16-foot channel down the dredged cut.

September 6 the dredge was moved to the foot of Island 21 (131). Dredging was commenced at 8.15 a. m. on the 10th, and at 6 p. m. of the same day the starboard pumping engine was completely wrecked, owing to the breaking of the connecting rod. The dredge was sent to the fleet and put out of commission on the 13th. The engine was repaired and the dredge again put in commission December 13.

Dredging was begun about noon, December 14, at Presidents Island (234) and continued until the 17th, when most of the day and part of the 18th was engaged in pulling the steamer *Delta* off the bar. This boat was grounded through no lack of water in the channel, as she was several hundred yards out of her proper course when she grounded. Dredging was continued until December 19, when it was necessary to suspend operations, as they were out of coal. Just as the dredge was about to move out of the channel a severe storm struck her, and before she could gather headway she was grounded at the stern. The drawbars connecting the discharge pipe to the stern of the dredge were broken. A barge of coal was procured on the 20th, and dredging was resumed at 4.45 p. m. of the 21st. At 5.30 p. m. the steamer *James Lee* needlessly ran into the coal barge and sunk it. As no more coal was available, the dredge was sent to the fleet and laid up. The work done at this crossing by this dredge resulted in a considerable improvement, and had she not been delayed by steamboats and shortage of coal the full channel depth could have been maintained. The least depth was 7½ feet for about a week.

Dredge Henry Flad.—This dredge left the fleet August 26 and went to the wharf at Memphis (230), where she was engaged in cutting off the lower end of a bar which had formed in front of the wharf. Dredging was continued, with numerous delays caused by the location and character of the work, until September 5, when it was successfully completed, and there was not less than 18 feet of water along the wharf front.

The dredge lay at the bank until the morning of September 28, when she left upstream, arriving at the foot of Island 21 (131) about noon, October 1. Dredging was begun at 10.35 a. m., October 2, and completed at noon, October 4. The results obtained were quite satisfactory, as there was a well-defined channel 18 feet in depth, and this remained the channel until the low stage in December.

The dredge went to the head of Island 21 October 5 and waited for a lower stage until the 9th, when dredging was begun with a single crew. The work was completed on the 14th and the dredge again went to the bank to await a lower stage, as there was then a good 17-foot channel.

The dredge went to Bixby's towhead (83), arriving October 26. Dredging was begun on the 28th and continued without serious interruption until the 31st, when one day was lost in repairing broken condenser valves and cleaning boilers. Dredging was resumed at 7 a. m. November 2 and continued until November 6, when boilers were again cleaned. Dredging was resumed November 8 and was completed on the 10th. There was then a well-defined channel 15 feet in depth. Dredging was resumed at the same point November 22 and continued without interruption until the 24th. There was then a good 15-foot channel and no further dredging was done at this point. The least water during the season was 8½ feet.

The dredge moved to Hathaway Crossing (103) November 24 and began dredging on the 25th, completing it on the 26th. There was then a good 15-foot steamboat channel and no further dredging was done at this point. The least depth reached on this crossing during the season was 9 feet. The dredge was sent to the fleet, arriving there November 28.

She again left the fleet upstream December 11, assisted by the steamer *Wynoka*. On the 13th the coal barge in tow, containing about 13,000 bushels of coal, struck a snag near Craigheads Point and was sunk. The dredge proceeded to New Haven, but, on account of lack of coal, was not able to do any dredging until the 18th. Work was continued, with numerous delays due to very stormy weather, until December 20, when work was discontinued, and the dredge moved to Gold Dust Crossing (158), where she ran aground. She was released by aid of the steamer *Search* on the 21st and began dredging at 9 p. m. of the same day. Work continued without serious interruption until the 23d, when it was completed, and there was a good 12-foot channel over the crossing.

The dredge left upstream at 12.30 p. m. December 23 and reached the foot of Island 21 on the 24th, and began dredging at 1.40 p. m. of the same day. Dredging was continued until 3.30 p. m. of the 25th, when the starboard boiler was bagged. This was repaired on the 28th, and as the river was rising and there was 12 feet in the crossing, the dredge was taken to New Haven December 29. Dredging began on the same day and continued until the 31st, when she was taken to the fleet and laid up. There was then 13½ feet in the crossing.

SURVEYS.

Three survey parties were put into the field in connection with dredging operations, as has been the custom for several years. One party covered that portion of the river between New Madrid (70) and Cottonwood Point (123), the second from Cottonwood Point to Island 34 (178), and the third covered the river between Memphis (230) and Ashley Point (274). Fifty-five surveys of troublesome bars were made during the season.

INSPECTION.

The steamer *Search* was used during the season as an inspection boat, and the office of the superintendent of dredging operations was maintained on her during the dredging season. The boat was constantly patrolling the river with a double crew for the purpose of not only keeping the superintendent fully informed of the condition of the river, but to also exercise general supervision over the operations of the dredges and survey parties. All supplies for the field parties were carried from Memphis on this boat.

The expense charged to "Inspection" on the table showing distribution of expenditures includes all the cost of administration, clerical expenses, including salaries, as well as the cost of operating the boat.

The steamer *Patrol* was used for one round trip from Memphis to Point Pleasant.

Round trips as follows were made from Memphis to—

Cairo	1
Medleys	1
New Madrid	5
Darnells Point	14
Hathaway	3
Caruthersville	1
Gold Dust	2
Peters Crossing	10
Graves Bayou	1
Choctaw Bend	1
Greenville	1
Total	40

A table is appended showing channel depths as observed on these various trips.

The following tables are also submitted: Distribution of expenditures for the entire year; distribution of time of dredges during low-water season.

Respectfully submitted.

F. B. MALTBY.
Assistant Engineer,
Superintendent of Dredging Operations.

Capt. WM. B. LADUE,
Corps of Engineers, U. S. Army,
Secretary Mississippi River Commission.

TABLE No. 6.—*Summary of dredging operations, Mississippi River below Cairo, during the low-water season of 1903.*

DELTA.

Points of operations.	Distribution of time.										Distance towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth suction lowered.	Average depth cut.	Average steam pressure per square inch.	Average speed main pump, revolutions per minute.
	Placing plant.	Dredging.	Changing cuts.	Repairing.	Passing boats.	Making up tow.	Towing.	Not working; awaiting lower stage, etc.	Total.									
	Hours.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*		*Miles.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Lbs.*	
Peters Crossing (272), Aug. 27–Sept. 28	9.15	186.55	14.00	53.00	....	6.00	6.30	499.15	774.55		40	14	11,810	63	19.4	5.4	149	133
Peters Crossing, second time, Sept. 28–Oct. 5	4.25	132.10	9.05	1.05	....	....	....	18.40	165.25		....	11	9,920	82	20.5	6.2	148	136
Presidents Island (235), Oct. 5–15	6.20	109.10	7.30	8.05	....	4.10	67.30	32.55	235.40		37	2	1,860	17	18.9	4.4	148	137
West Memphis (232 R), lying up, Oct. 15–Nov. 4	....	....	....	....	....	3.15	1.30	477.15	482.00		3	....	....	....	....	....	....	....
Presidents Island, second time, Nov. 4–20	4.10	264.15	12.55	19.45	....	1.30	1.05	79.20	383.00		3	15	10,500	40	19.3	5.6	150	137
West Memphis, second time, lying up, Nov. 20–Dec. 13	....	....	....	....	....	1.15	1.30	553.45	556.30		3	....	....	....	....	....	....	....
Random Shot (192), Dec. 13–18	4.30	59.10	3.30	1.05	....	3.00	43.15	....	114.30		40	6	4,440	75	18.0	7.6	145	130
Chute of Island 20 (127), Dec. 18–24	3.05	39.50	2.30	[a]5.50	....	4.00	63.30	26.15	145.00		65	6	3,540	89	14.8	6.7	146	130
Darnells (81), Dec. 24–29	3.15	18.35	1.00	....	0.45	3.40	42.20	44.05	113.40		46	3	2,520	136	17.0	5.0	144	130
Joe Eckles (93), Dec. 29–30	2.05	9.10	0.40	....	4.00	2.50	8.00	19.35	46.20		12	4	2,160	236	18.0	3.5	145	130
Moving into winter quarters, Dec. 30–Jan. 2	....	....	....	....	....	2.00	56.50	....	58.50		139	....	....	....	....	....	....	....
Total and average	37.05	819.15	51.10	88.50	4.45	31.40	292.00	1,751.05	3,075.50		388	61	46,750	58	18.2	5.8	147	133

EPSILON.

Points of operations.	Placing plant.	Dredging.	Changing cuts.	Repairing.	Passing boats.	Making up tow.	Towing.	Not working; awaiting lower stage, etc.	Total.	Distance towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth suction lowered.	Average depth cut.	Average steam pressure per square inch.	Average speed main pump, revolutions per minute.
Luxora (161), Sept. 9–29	5.05	13.48	22.55	0.42	....	3.55	34.40	405.30	486.35	71	17	6,225	451	17.0	2.5	127	170
Last Chance (166), Sept. 29–Oct. 2	7.53	43.08	15.07	5.02	....	0.30	1.50	....	73.30	5	23	12,725	295	16.5	1.5	134	172
Gold Dust (158), Oct. 2–21	4.08	52.42	12.15	0.10	....	2.35	19.15	358.35	449.40	8	15	10,035	190	16.5	2.6	134	173
Moving into winter quarters, Oct. 21–22	....	....	....	....	....	2.35	22.45	....	25.20	74	....	....	....	....	....	....	....
Total and average	17.06	109.38	50.17	5.54	....	9.35	78.30	764.05	1,035.05	158	55	28,985	264	16.7	2.1	132	172

[a] Repairs to engine of steamer Wynoka.

TABLE NO. 6.—*Summary of dredging operations, Mississippi River below Cairo, during the low-water season of 1903*—Continued.

ZETA.

Points of operations.	Distribution of time.									Distance towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth suction lowered.	Average depth cut.	Average steam pressure per square inch.	Average speed main pump, revolutions per minute.
	Placing plant.	Dredging.	Changing cuts.	Repairing.	Passing boats.	Making up tow.	Towing.	Not working; awaiting lower stage, etc.	Total.								
	Hours.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Miles.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Lbs.*	
Joe Eckles (93), Aug 14-Sept. 15	16.15	96.55	14.50	1.30	....	5.00	109.10	525.30	769.10	139	24	14,450	149	16.0	2.0	130	174
Cherokee (90), Sept. 15-Oct. 2	3.00	30.50	7.50	....	....	....	4.45	359.55	406.20	3	10	7,100	231	16.0	1.5	133	175
Joe Eckles, second time, Oct. 2-10	3.15	22.50	3.55	....	....	1.45	1.55	158.30	192.10	3	9	5,800	254	16.0	0.9	133	175
Hathaways (103), Oct. 10-22	3.50	33.40	5.50	....	....	2.15	3.00	239.10	287.45	10	16	10,525	312	17.5	1.6	134	175
Moving into winter quarters, Oct. 22-23	....	....	....	....	....	1.05	28.25	....	29.30	129	....	....	....	....	....	....	....
Total and average	26.20	184.15	32.25	1.30	....	10.05	147.15	1,283.05	1,684.55	284	59	37,875	205	16.3	1.6	132	175

IOTA.

Points of operations.	Placing plant.	Dredging.	Changing cuts.	Repairing.	Passing boats.	Making up tow.	Towing.	Not working; awaiting lower stage, etc.	Total.	Distance towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth suction lowered.	Average depth cut.	Average steam pressure per square inch.	Average speed main pump, revolutions per minute.
Lazelles (83), Aug. 4-Sept. 1	6.00	47.30	4.00	27.30	....	7.30	192.30	411.00	696.00	151	12	9,500	209	18.0	2.7	147	158
Lazelles, second time, Sept. 2-29	3.15	31.27	5.30	0.45	....	1.00	2.10	627.53	672.00	4	9	7,650	243	18.0	1.7	148	158
Lazelles, third time, Sept. 2-Oct. 22.	3.10	83.59	9.01	10.25	....	....	0.55	430.55	538.25	....	19	16,650	198	18.0	2.5	149	161
New Madrid (72), Oct. 22-Nov. 4	2.17	56.33	11.20	12.25	....	....	36.27	189.03	308.05	85	6	5,100	90	18.0	6.4	145	161
Hathaway (103), Nov. 4-18	5.20	71.06	3.39	4.46	....	4.45	21.50	220.54	332.20	31	13	10,400	146	18.0	3.6	133	160
Moving into winter quarters, Nov. 18-19	....	....	....	....	....	3.00	32.40	....	35.40	129	....	....	....	....	....	....	....
In commission at fleet, Dec. 12-Jan. 3.	....	....	....	....	....	....	....	552.00	552.00	....	....	....	....	....	....	....	....
Total and average	20.02	290.35	33.30	55.51	....	16.15	286.32	2,431.45	3,134.30	400	59	49,300	171	18.0	3.1	145	159

KAPPA.

Hathaway (103), Aug. 19–Sept. 6	1.00	50.30	4.00	1.00	1.00	2.00	82.25	294.30	436.25	129	8	7,950	157	17.0	3.5	152	129
Miss Hickmans or Island 21 (131), Sept. 6–11	1.45	8.50	1.00	27.55	......	2.00	3.45	87.15	132.30	28	3	1,750	198	18.0	3.4	151	129
West Memphis, lying up, Sept. 11–13	......	......	......	7.00	......	2.00	25.30	......	34.30	101	......	......	......	......	......	......	......
Presidents Island (236), Dec. 14–24	9.00	55.15	2.15	24.30	35.00	1.55	10.05	99.40	237.40	4	4	4,150	75	12.0	4.5	143	126
Moving into winter quarters, Dec. 24	......	......	......	......	......	0.50	1.40	......	2.30	4	......	......	......	......	......	......	......
In commission at fleet, Dec. 24–Jan. 3	......	......	......	......	......	......	......	253.50	253.50	......	......	......	......	......	......	......	......
Total and average	11.45	114.35	7.15	60.25	36.00	8.45	123.25	735.15	1,097.25	266	15	13,850	121	16.0	3.8	149	128

HENRY FLAD.

Memphis wharf (230), Aug. 26–Sept. 5	3.30	146.35	6.05	45.35	......	4.00	1.10	37.00	243.55	2	......	......	......	......	......	......	......
West Memphis, lying up, Sept. 5–28	......	......	......	......	......	1.30	.45	542.15	544.30	2	......	......	......	......	......	......	......
Miss Hickmans or Island 21 (131), Sept. 28–Oct. 5	22.15	42.50	5.05	1.40	......	......	78.35	25.40	176.05	101	8	6,995	163	18.0	3.8	140	132
Chute of Island 20 (126), Oct. 5–22	.30	33 .15	6.50	......	......	......	5.00	354.50	400.25	5	7	4,825	145	19.0	2.9	139	132
Lazelles (83), Oct. 22–Nov. 16	5.50	191.50	22.10	19.55	......	......	57.30	[a]303.05	600.20	63	29	22,980	120	19.0	4.2	146	132
Lazelles, second time, Nov. 16–24	2.35	44.30	2.20	......	......	4.55	44.45	94.10	193.15	37	7	5,950	134	18.0	6.6	143	132
Hathaways (103), Nov. 24–27	3.15	23.50	3.40	......	......	3.55	4.00	33.05	71.45	20	5	3,150	132	17.0	4.2	148	132
West Memphis, lying up, Nov. 27–Dec. 11	......	......	......	......	......	......	33.00	302.20	335.20	129	......	......	......	......	......	......	......
New Haven (162), Dec. 11–20	[b]19.15	22.30	19.45	......	......	......	37.15	120.50	219.35	70	3	2,225	99	13.0	5.9	147	131
Gold Dust (158), Dec. 20–23	[c]24.00	30.05	2.25	8.40	1.35	......	2.40	......	69.25	4	5	3,550	118	13.0	5.6	141	132
Miss Hickmans, second time, Dec. 23–29	4.15	16.10	1.10	8.30	......	4.30	21.00	86.50	142.25	27	3	2,375	147	13.0	4.8	144	132
New Haven, second time, Dec. 29–Jan. 1	2.55	36.45	3.30	.50	......	......	4.30	25.55	74.25	31	5	3,800	103	16.0	6.6	146	132
Moving into winter quarters, Jan. 1–2	......	......	......	......	......	......	24.10	......	24.10	70	......	......	......	......	......	......	......
In commission at fleet, Jan. 2–3	......	......	......	......	......	......	......	39.05	39.05	......	......	......	......	......	......	......	......
Total and average	88.20	588.20	73.00	85.10	1.35	18.50	314.20	1,965.05	3,134.40	561	72	55,850	126	16.0	4.7	144	132

[a] Includes one week lying up at Hathaways (103).

[b] Includes 17 hours 40 minutes getting steamer Choctaw off bar.

[c] Includes time getting dredge off bar.

TABLE No. 7.—*Cost of dredging operations, April 1, 1903, to March 31, 1904.*

	Labor.	Office supplies.	Subsistence.	Fuel.	Lighting supplies.	Lubricants.	Repairs.	New plant.	Total.	Grand total.
Care of plant	$36,787.75	$196.54	$6,493.31	$5,771.68	$146.23	$235.15	$812.56			$50,443.22
Repairs to plant:										
Dredge Beta	8,432.75	1.05	1,048.07	126.31	.70	11.51	2,158.39		$6,773.78	
Dredge Gamma	140.63		24.14			12.46	130.03		307.26	
Dredge Delta	1,590.68		285.56		4.84	29.17	1,493.28		3,403.53	
Dredge Epsilon	342.79	.52	61.44		1.36	16.52	346.42		769.05	
Dredge Zeta	482.83		103.16		1.64	.86	282.34		870.33	
Dredge Iota	1,466.17	.28	211.50	7.94	1.40	14.12	1,296.74		2,998.15	
Dredge Kappa	2,755.03		550.62		8.90	37.64	2,030.98		5,383.17	
Dredge Henry Flad	894.18	.11	144.82		5.39	33.25	1,173.10		2,250.85	
Steamer Sachem	3,045.71		566.37		5.98	19.65	1,531.28		5,168.99	
Steamer Choctaw	2,562.04		459.46	54.87	11.81	12.11	1,666.21		4,766.50	
Steamer Nokomis	1,551.85		253.93	35.43	4.89	6.97	1,288.02		3,141.09	
Steamer Wynoka	3,507.39	.64	706.83	891.30	36.76	102.23	9,728.50		14,973.65	
Steamer Leota	1,831.04		292.94		3.36	24.52	2,319.23		4,471.09	
Steamer Minnetonka	171.05		28.30				194.67		394.02	
Steamer Search	3,637.17		689.76		3.38	27.51	1,901.65		6,259.47	
Steamer Vulcan	93.83		15.65				89.80		149.28	
Steamer Venus	168.63		37.45		.10	1.14	66.79		274.11	
Steamer Mars	212.90		40.94		.18		63.21		317.18	
Steamer Mercury	181.51		36.15		.25	2.39	48.61		268.91	
Pile sinker No. 61	6.66		.67			.80	14.54		22.67	
Pile sinker No. 971	871.64		125.25			1.56	224.88		1,223.33	
Pile sinker No. 981	128.50		17.42			1.16	66.01		213.09	
Pile sinker No. 982	149.49		24.79			3.58	73.20		251.06	
Pile sinker No. 983	392.59		60.99				104.81		558.39	
Pile sinker No. 984	110.76		19.57			3.18	60.32		193.83	
Quarterboat No. 13	25.17		3.87						29.04	
Skiffs	141.78		26.09				43.86		211.68	
Tools and appliances	685.72		121.85			1.94	170.06		979.07	
Total	30,579.94	2.60	5,957.09	1,115.85	90.89	364.27	28,511.93		66,622.57	66,622.57
Operations during low-water season, 1903:										
Dredge Delta	12,737.78	15.62	2,895.03	10,199.84	98.99	498.05	403.70		26,848.51	
Dredge Epsilon	5,983.93	6.85	1,455.27	2,158.64	80.20	114.66	815.12		10,559.17	
Dredge Zeta	6,809.14	8.60	1,681.95	5,381.24	54.35	168.65	193.97		14,297.90	
Dredge Iota	8,946.62	12.52	2,359.82	6,556.95	43.62	277.18	702.19		18,897.35	
Dredge Kappa	5,158.87	8.61	1,154.23	3,648.58	49.67	204.10	274.65		10,498.21	
Dredge Henry Flad	9,437.65	8.22	2,127.83	10,297.86	86.99	208.77	175.42		22,292.74	

Steamer Search	6,562.96	25.50	1,393.21	2,455.30	21.54	88.21	24.23		10,570.95	
Steamer Vulcan	1,053.83	22.41	257.57	250.62	7.71	10.98	9.43		1,612.55	
Steamer Venus	1,657.65	27.35	313.73	296.71	9.61	15.45	12.22		2,332.72	
Steamer Mercury	2,078.33	32.11	467.05	458.85	20.81	28.47	18.17		3,103.79	
Total	60,426.26	167.29	14,105.19	41,698.09	373.49	1,609.47	2,634.10		121,013.89	121,013.89
New plant:										
Grounds	1,509.92		355.66			2.57	799.63		2,667.78	
Machine shop	89.24		24.46		.10		1,019.16		1,132.96	
Sectional docks	113.03		17.45				55.64		186.12	
Barges	26.08		5.60				22.00		53.68	
Tools, appliances, and outfit								5,955.12	5,955.12	
Total	1,738.27		403.17		.10	2.57	1,896.43	5,955.12	9,995.56	9,995.56
Testing dredges	660.59		114.77	219.92	.10	46.17	23.06			1,064.61

TABLE No. 8.—*Depths over shoal crossings, Mississippi River below Cairo, low-water season of 1903.*

Crossing.	Miles below Cairo.	Dates of trips, 1903.													
		Aug. 13-15.	Aug. 18-21.	Aug. 23-24.	Aug. 25.	Aug. 30.	Sept. 2.	Sept. 4-5.	Sept. 11-13.	Sept. 29-30.	Oct. 2.	Oct. 9-10.	Oct. 11.	Oct. 22.	Oct. 28-29.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Cairo gauge	0	19.5 to 19.1	18.7 to 18.3	18.3 to 18.0	17.7F	15.4S	16.1R	17.7 to 18.6	18.0 to 18.4	16.0 to 16.0	16.3S	17.3 to 17.9	18.5R	17.8F	16.3 to 15.9
Medleys	29														
Lesters	55														
New Madrid gauge	70													14.8F	13.5F
New Madrid crossing	71													12.0	
Toneys	75														19.0
Marrs	77														
Darnells	81									15.0				17.0	
Lazelles	83		14.0			14.0			13.0	13.0		12.5		13.5	13.5
Cherokee	90		16.5			14.0		15.0		14.0		16.5		15.0	16.0
Joe Eckles	92		17.0		16.0	15.0		17.0		15.0		17.5		17.0	13.0
Carey's woodyard			16.0												
Hathaway	103		14.0		14.0	16.0		17.0		15.0		14.5		15.0	13.0
Booths Point	118														
Island 18	120														
Cottonwood Point gauge	123	13.5F			12.5F	10.5F		12.0R	12.0F	11.0F		11.2R		12.0F	10.5F
Chute Island 20	127	18.0			17.0	15.5		17.5	17.0	15.0		14.5		17.0	16.0
Miss Hickmans, or Foot Island 21	131	16.0			17.0	14.0		16.0		12.0		17.5		20.0	13.5
Gold Dust	158				17.5	13.0				13.0		16.0	16.0		13.0
Luxora	161	16.0			15.0	12.0			14.0	15.0		14.5	15.0		14.5
New Haven	162	18.0			17.5					16.0		16.5			
Last Chance	166	15.0			18.0	15.0				14.0		17.0	18.0		17.0
Fulton gauge	175	13.3S						11.2R		11.2F		11.0R	11.5R		10.8F
Random Shot	192								16.5						
Densfords															
Corona	208														
Chickasaw Bluffs	222														
Memphis gauge	230			11.7R	11.75F		9.6R	10.0R	11.8R		9.8R	10.0R			
Presidents Island	235						18.0				12.5				
Fleeces	243			16.5							13.5				
Graves Bayou	250			17.0			16.0				16.5				
Cat Island	253														
Norfolk	254			17.0											
Star Crossing	260														
Polks	266			19.0											
Blues Point	270			23.0											
Peters	272			11.5			10.0				14.0				

Ashley Point	274			18.0											
Mhoons	275														
Mhoons gauge	276														
Hardins Point	290														
Helena gauge	306														
Montezuma	312														
Island 63	332														
Island 66	353														
Sunflower gauge	353														
Andersons	359														
Indian Point	406														
Mouth White River gauge	393														
Catfish Towhead	421														
Choctaw Bend	435														
Moss Lake	456														
Greenville gauge	478														

TABLE No. 8.—*Depths over shoal crossings, Mississippi River below Cairo, low-water season of 1903*—Continued.

Crossing.	Miles below Cairo.	Dates of trips, 1903.											
		Oct. 30.	Nov. 3-4.	Nov. 13-16.	Nov. 19-21.	Nov. 30 to Dec. 4.	Dec. 8-11.	Dec. 14-17.	Dec. 17-18.	Dec. 19-20.	Dec. 20-22.	Dec. 24-27.	Dec. 29, 1903, to Jan. 2, 1904.	
													Down.	*Up.*
Cairo gauge	0	*Feet.* 15.7F	*Feet.* 15.2 to 15.0	*Feet.* 14.6 to 13.1	*Feet.* 12.1 to 11.4	*Feet.* 11.6 to 10.4	*Feet.* 8.0 to 6.8	*Feet.* 5.8 to 3.5	*Feet.* 3.6 to 3.2	*Feet.* 3.1 to 3.0	*Feet.* 2.85 to 4.9	*Feet.* 8.6 to 10.8	*Feet.* 11.7 S	*Feet.* 12.0 R
Medleys	29			19.0										
Lesters	55			17.0										
New Madrid gauge	70		12.5F	11.5F					3.6F					
New Madrid Crossing	71		18.0	16.0										
Toneys	75													
Marrs	77			13.5										
Darnells	81		14.0	11.5	12.0		9.0	7.0				11.0		
Lazelles	83		13.5	13.5	11.5		10.0	8.5				11.5		
Cherokee	90		14.0	12.0	12.0		9.0	8.0				11.0		
Joe Eckles	92		13.5	13.0	12.0		9.0	7.5				12.5		
Carey's woodyard														
Hathaway	103		11.0	12.0	11.5		9.0	9.0				14.5		
Booths Point	118										10.0			
Island 18	120						12.5				9.0			
Cottonwood Point gauge	123		9.5F	8.5F	7.3F		4.0F	2.0F			.5R	3.2R		
Chute Island 20	127		14.0	12.0	12.0		10.0	8.0			6.5	10.0		
Miss Hickmans, or Foot Island 21	131		14.0	10.5	12.0		8.5	8.0			6.5	10.0		
Gold Dust	158		12.0	11.0	11.0		7.5	8.0			6.5	10.5		
Luxora	161			11.0	10.0									
New Haven	162						8.0	8.0			7.0	9.0		
Last Chance	166		17.0				10.5		9.5					
Fulton gauge	175		10.0F		7.7F		4.3F	3.2F			1.5F	2.2R		
Random Shot	192				12.0		7.5	6.5	10.0		10.0	10.5		
Densfords								10.0			10.0			
Corona	208								10.0					
Chickasaw Bluffs	222								10.0					
Memphis gauge	230	9.8F				6.0F	4.2F	2.9F	2.1F	1.3F		1.3R	5.0R	
Presidents Island	235	12.5				11.5	9.0			7.5			12.0	14.0
Fleeces	243	13.0				13.0				11.0			14.5	15.0
Graves Bayou	250	16.0				14.0				8.0			13.0	13.0
Cat Island	253								9.4	10.4				
Norfolk	254					15.0								
Star Crossing	260					14.0			9.0					
Polks	266					13.0			8.7	7.9			11.5	14.0

Blues Point	270								11.0	11.5				
Peters	272	16.0				12.0			8.0	8.0			10.5	14.0
Ashley Point	274	17.5							9.3	8.8				
Mhoons	275					12.0			8.3	7.9			12.0	13.0
Mhoons gauge	276					4.3R								
Hardins Point	290					18.0								
Helena gauge	306					9.0R			4.6F					
Montezuma	312					12.0				8.8			12.0	
Island 63	332					18.5								
Island 66	353					12.0							16.5	
Sunflower gauge	353					9.5F							8.0R	9.5R
Andersons	359					11.0							11.5	18.5
Indian Point	406					13.0							12.0	14.0
Mouth White River gauge	393					12.5F							10.2R	11.7R
Catfish Towhead	421					12.0							12.0	
Choctaw Bend	435					13.0							10.0	16.0
Moss Lake	456												11.5	
Greenville gauge	478												6.0R	

TABLE No. 9.—*Testing Dredges.*

[Data and results of main pump tests of dredge *Zeta*.]

3-BLADED RUNNER.

Revolutions.	Steam pressure.	Total indicated horsepower.	Suction pipes.		Discharge pipe.					Heads, feet of water.				Work done per second.	Efficiency of pumps and engine.	Efficiency of pump.	Peripheral velocity per second.
			Mean velocity per second.	Velocity head of water.	Center velocity per second.	Mean velocity per second.	Velocity head of water.	Discharge per second.	Discharge per second.	Suction.	Delivery.	Velocity.	Total.				
	Pounds.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Pounds.*					*Foot-lbs.*	*P. Ct.*	*P. Ct.*	*Feet.*
178 per minute	120	592.08	13.701	2.92	19.397	15.735	3.85	87.880	5,492.50	8.22	33.86	0.93	43.01	236,232.43	72.50	78.8	53.5900
180 per minute	130	622.08	13.727	2.93	19.434	15.765	3.86	88.048	5,503.00	7.99	34.65	.93	43.57	239,765.71	70.10	76.3	54.1920
178 per minute	121	591.51	14.644	3.33	20.732	16.818	4.40	93.929	5,870.56	7.85	33.83	1.07	42.75	250,966.44	77.10	83.8	53.5900
180 per minute	130	640.94	13.819	2.97	19.565	15.871	3.92	88.640	5,540.00	7.58	35.02	.95	43.55	241,267.00	68.40	74.3	54.1920
176 per minute	137	551.12	13.164	2.69	18.636	15.118	3.55	84.434	5,277.13	7.24	32.14	.86	40.24	214,351.71	70.00	76.1	53.0680
169 per minute	127	524.47	13.026	2.64	18.442	14.960	3.48	83.552	5,222.00	7.08	31.58	.84	39.50	206,269.00	71.50	77.7	50.8800
Mean	....	587.03	13.680	2.91	19.334	15.711	3.84	87.746	5,484.20	7.66	33.51	.93	42.10	231,475.38	71.60	77.8	53.2530
5-BLADED RUNNER.																	
150 per minute[a]	132	483.85	12.321	2.36	17.443	14.150	3.08	79.028	4,939.25	5.85	29.81	0.72	36.38	179,689.91	67.50	72.9	45.1605
159 per minute[a]	134	571.15	13.067	2.65	18.500	15.007	3.50	83.814	5,238.38	6.47	33.75	.85	41.07	215,140.26	68.40	73.9	47.8700
170 per minute	126	690.40	14.231	3.15	20.150	16.347	4.15	91.298	5,706.12	7.72	39.60	1.00	48.32	275,719.72	72.60	78.4	51.1819
171 per minute	125	712.06	14.304	3.18	20.250	16.428	4.19	91.750	5,734.37	7.85	41.29	1.01	50.15	287,578.65	73.40	79.3	51.4830
175 per minute	129	734.07	14.347	3.20	20.310	16.477	4.22	92.024	5,751.50	8.28	40.16	1.02	49.46	284,469.19	70.40	76.0	52.6873
Mean	....	712.18	14.295	3.18	20.237	16.417	4.19	91.691	5,730.66	7.95	40.35	1.01	49.31	282,589.19	72.10	77.9	51.7831

	274	18.0
	275	
Mhoons gauge	276	
Hardins Point	280	
Helena gauge	306	
Montezuma	312	
Island 63	332	
Island 66	353	
Sunflower gauge	368	
Andersons	389	
Indian Point	406	
Mouth White River gauge	408	
Catfish Towhead	421	
Choctaw Bend	435	
Moss Lake	456	
Greenville gauge	478	

TABLE No. 8.—*Depths over shoal crossings, Mississippi River below Cairo, low-water season of 1903*—Continued.

Crossing.	Miles below Cairo.	Dates of trips, 1903. Oct. 30.	Nov. 3-4.	Nov. 13-16.	Nov. 19-21.	Nov. 30 to Dec. 4.	Dec. 8-11.	Dec. 14-17.	Dec. 17-18.	Dec. 19-20.	Dec. 20-22.	Dec. 24-27.	Dec. 29, 1903, to Jan. 2, 1904. *Down.*	Dec. 29, 1903, to Jan. 2, 1904. *Up.*
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Cairo gauge	0	15.7F	15.2 to 15.0	14.6 to 13.1	12.1 to 11.4	11.6 to 10.4	8.0 to 6.8	5.8 to 3.5	3.6 to 3.2	3.1 to 3.0	2.85 to 4.9	8.6 to 10.8	11.7 S	12.0 R
Medleys	29			19.0										
Lesters	55			17.0										
New Madrid gauge	70		12.5F	11.5F					3.6F					
New Madrid Crossing	71		18.0	16.0										
Toneys	75													
Marrs	77			13.5										
Darnells	81		14.0	11.5	12.0		9.0	7.0				11.0		
Lazelles	83		13.5	13.5	11.5		10.0	8.5				11.5		
Cherokee	90		14.0	12.0	12.0		9.0	8.0				11.0		
Joe Eckles	92		13.5	13.0	12.0		9.0	7.5				12.5		
Carey's woodyard														
Hathaway	103		11.0	12.0	11.5		9.0	9.0				14.5		
Booths Point	118										10.0			
Island 18	120						12.5				9.0			
Cottonwood Point gauge	123		9.5F	8.5F	7.3F		4.0F	2.0F			.5R	3.2R		
Chute Island 20	127		14.0	12.0	12.0		10.0	8.0			6.5	10.0		
Miss Hickmans, or Foot Island 21	131		14.0	10.5	12.0		8.5	8.0			6.5	10.0		
Gold Dust	158		12.0	11.0	11.0		7.5	8.0			6.5	10.5		
Luxora	161			11.0	10.0									
New Haven	162						8.0	8.0			7.0	9.0		
Last Chance	166		17.0				10.5		9.5					
Fulton gauge	175		10.0F		7.7F		4.3F	3.2F			1.5F	2.2R		
Random Shot	192				12.0		7.5	6.5	10.0		10.0	10.5		
Densfords								10.0			10.0			
Corona	208								10.0					
Chickasaw Bluffs	222								10.0					
Memphis gauge	230	9.8F				6.0F	4.2F	2.9F	2.1F	1.3F		1.3R	5.0R	
Presidents Island	235	12.5				11.5	9.0			7.5			12.0	14.0
Fleeces	243	13.0				13.0				11.0			14.5	15.0
Graves Bayou	250	16.0				14.0				8.0			13.0	13.0
Cat Island	253								9.4	10.4				
Norfolk	254					15.0								
Star Crossing	260					14.0			9.0					
Polks	266					13.0			8.7	7.9			11.5	14.0

Blues Point	270								11.0	11.5				
Peters	272	16.0				12.0			8.0	8.0			10.5	14.0
Ashley Point	274	17.5							9.3	8.8				
Mhoons	275					12.0			8.3	7.9			12.0	13.0
Mhoons gauge	276					4.3R								
Hardins Point	290					18.0								
Helena gauge	306					9.0R			4.6F					
Montezuma	312					12.0				8.8			12.0	
Island 63	332					13.5								
Island 66	353					12.0							16.5	
Sunflower gauge	353					9.5F							8.0R	9.5R
Andersons	359					11.0							11.5	13.5
Indian Point	406					13.0							12.0	14.0
Mouth White River gauge	393					12.5F							10.2R	11.7R
Catfish Towhead	421					12.0							12.0	
Choctaw Bend	435					13.0							10.0	16.0
Moss Lake	456												11.5	
Greenville gauge	478												6.0R	

APPENDIX 1 D.

REPORT OF ASSISTANT ENGINEER F. B. MALTBY ON EFFICIENCY TESTS OF HYDRAULIC DREDGES, SUPPLEMENTAL TO REPORT OF 1903.

MEMPHIS, TENN., *April 27, 1904.*

CAPTAIN: My last annual report was accompanied by a special report covering certain tests of the efficiency of the machinery on the dredges under consideration. Since that time some additional tests have been made, the results of which are submitted, as follows:

EFFICIENCIES OF A CENTRIFUGAL PUMP HAVING A RUNNER WITH A VARYING NUMBER OF BLADES.

The main sand pump on the dredge *Zeta*, when tested in 1902, had a runner with five blades. To determine the effect of the number of blades, tests were made on May 22, 1903, with a runner having seven blades, and on July 21 with one having three blades.

The outside diameter at the tip, the diameter at the inside shoulder of the blades, and the degree of curvature of the face of the blades, as well as the amount of clearance between the runner and pump casing, were practically the same in each case; conditions of operation were as nearly the same during each test as it was practicable to make them. The instruments used and methods employed in making observations were the same as described in my previous report.

A table of data and results is submitted herewith.

In the mean results for each runner it will be noted that certain observations have been omitted. This was done not through any lack of confidence in the accuracy of results, but because they covered speeds widely different from those observed with the other runners.

The mean efficiencies of engine and pump with runners having three, five, and seven blades are 71.6, 72.1, and 73.1 per cent, respectively, a total difference of only about 1½ per cent.

From these results it appears that, considering mechanical efficiency only, the number of blades has very little effect.

The capacity or total amount of work done with the different runners varies to a greater extent, being 231,475 foot-pounds per second with three blades, 282,589 and 288,518 with five and seven blades, respectively, or the runner with five blades did 22 per cent and the one with seven blades did 24 per cent more work than the three-bladed runner.

On October 23, 1903, capacity and efficiency tests of one of the centrifugal sand pumps on the *Beta* were made, and on the 24th a test of two of her boilers was made; and on October 28 tests were made with the pump on the *Iota*, the runner of which had been converted into one of the inclosed type, but othewise remaining the same since the tests were made in 1902.

Certain errors were discovered in the table of results with the *Iota's* pump in 1902, and a table is submitted herewith showing data and results with the *Beta's* pump and with the one on the *Iota* with an open and shrouded runner.

The *Beta's* efficiency at ordinary speeds of operation is only about 55 per cent, not quite as good as the *Delta*. I know of no reason for this except that it is due to the type of pump. The clearance between the runner and the casing is slightly more than on some of the other pumps, but I do not believe that it is enough more to account for all the differences in efficiency.

The table also shows the additional efficiency, and especially the capacity, obtained by putting the shrouded runner on the *Iota*. The efficiency of the engine and pump at 168 revolutions per minute is about 76 per cent, which is the highest efficiency we have yet obtained, and is over 10 per cent greater than that obtained with the open runner. The average amount of work done is 341,500 foot-pounds per second, as against 310,800 with the open runner at the same speed, an increase of nearly 10 per cent.

In this connection attention is invited to the table, and especially in reference to the capacity of the pumps at different speeds. A diagram is inclosed showing graphically the work done by each dredge in thousands of foot-pounds per second by each pump at varying peripheral velocities. In every case it will be noted that the capacity of the pump increases to a very marked degree to the maximum speed, with no indication that the speed for maximum capacity has been reached on any pump. The efficiencies at varying speeds are also plotted on the same sheet and show very little difference at different speeds. Generally speaking, the efficiencies are slightly lower at the higher speeds, except on the *Beta*, where the efficiency seems to increase slightly with the speed. This is true also on the *Iota*.

In the whole series of experiments, leaving out only the *Beta* and *Delta*, whose efficiencies are so much lower than the others as to be very marked, the whole range of speed from 42 to 55 feet per second, or 30 per cent increase, has been followed by an extreme range of efficiency of from about 63 per cent to 75 per cent, while the range in capacities is over 200 per cent of the lowest. Evidently, then, regarding mechanical efficiency alone, speed, within reasonable limits, makes very little difference; but to obtain the maximum output from the plant the pumps should be run at as high a speed as is practicable.

BOILER TESTS.

The results of the boiler tests on the *Beta*, which has Heine water-tube boilers, show an efficiency of 9.15 pounds of water evaporated per pound of combustible, as against 9.34 pounds with those on the *Delta*, which are of the same type. This difference is so small that it is believed that the mean of 9.25 pounds represents very accurately the efficiency of this class of boilers. As pointed out in my previous report, the mean efficiency of 36 boilers of the Mississippi River type was 9.1 pounds of water evaporated into dry steam from and at 212 degrees per pound of combustible, and, therefore, for our use certainly there is no economy in the water-tube boilers.

Respectfully submitted.

F. B. Maltby,
Assistant Engineer, Superintendent Dredging Operations.

Capt. Wm. B. Ladue,
Corps of Engineers, U. S. A.,
Secretary Mississippi River Commission.

TABLE No. 9.—*Testing Dredges.*

[Data and results of main pump tests of dredge *Zeta*.]

3-BLADED RUNNER.

Revolutions.	Steam pressure.	Total indicated horsepower.	Suction pipes.		Discharge pipe.			Discharge per second.	Discharge per second.	Heads, feet of water.				Work done per second.	Efficiency of pumps and engine.	Efficiency of pump.	Peripheral velocity per second.
			Mean velocity per second.	Velocity head of water.	Center velocity per second.	Mean velocity per second.	Velocity head of water.			Suction.	Delivery.	Velocity.	Total.				
	Pounds.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Pounds.*					*Foot-lbs.*	*P. Ct.*	*P. Ct.*	*Feet.*
178 per minute	120	592.08	13.701	2.92	19.397	15.735	3.85	87.880	5,492.50	8.22	33.86	0.93	43.01	236,232.43	72.50	78.8	53.5900
180 per minute	130	622.08	13.727	2.93	19.434	15.765	3.86	88.048	5,503.00	7.99	34.65	.93	43.57	239,765.71	70.10	76.3	54.1920
178 per minute	121	591.51	14.644	3.33	20.732	16.818	4.40	93.929	5,870.56	7.85	33.83	1.07	42.75	250,966.44	77.10	83.8	53.5900
180 per minute	130	640.94	13.819	2.97	19.565	15.871	3.92	88.640	5,540.00	7.58	35.02	.95	43.55	241,267.00	68.40	74.3	54.1920
176 per minute	137	551.12	13.164	2.69	18.636	15.118	3.55	84.434	5,277.13	7.24	32.14	.86	40.24	214,351.71	70.00	76.1	53.0680
169 per minute	127	524.47	13.026	2.64	18.442	14.960	3.48	83.552	5,222.00	7.08	31.58	.84	39.50	206,269.00	71.50	77.7	50.8800
Mean	....	587.03	13.680	2.91	19.334	15.711	3.84	87.746	5,484.20	7.66	33.51	.93	42.10	231,475.38	71.60	77.8	53.2530

5-BLADED RUNNER.

Revolutions.	Steam pressure.	Total indicated horsepower.	Suction pipes.		Discharge pipe.			Discharge per second.	Discharge per second.	Heads, feet of water.				Work done per second.	Efficiency of pumps and engine.	Efficiency of pump.	Peripheral velocity per second.
			Mean velocity per second.	Velocity head of water.	Center velocity per second.	Mean velocity per second.	Velocity head of water.			Suction.	Delivery.	Velocity.	Total.				
150 per minute[a]	132	483.85	12.321	2.36	17.443	14.150	3.08	79.028	4,939.25	5.85	29.81	0.72	36.38	179,689.91	67.50	72.9	45.1605
159 per minute[a]	134	571.15	13.067	2.65	18.500	15.007	3.50	83.814	5,238.38	6.47	33.75	.85	41.07	215,140.26	68.40	73.9	47.8700
170 per minute	126	690 40	14.234	3.15	20.150	16.347	4.15	91.298	5,706.12	7.72	39.60	1.00	48.32	275,719.72	72.60	78.4	51.1819
171 per minute	125	712.06	14.304	3.18	20.250	16.428	4.19	91.750	5,734.37	7.85	41.29	1.01	50.15	287,578.65	73.40	79.3	51.4830
175 per minute	129	734.07	14.347	3.20	20.310	16.477	4.22	92.024	5,751.50	8.28	40.16	1.02	49.46	284,469.19	70.40	76.0	52.6873
Mean	....	712.18	14.295	3.18	20.237	16.417	4.19	91.691	5,730.66	7.95	40.35	1.01	49.31	282,589.19	72.10	77.9	51.7831

7-BLADED RUNNER.

180 per minute	135	764.52	15.235	3.61	21.603	17.496	4.76	97.715	6,107.19	6.90	40.73	1.15	48.78	297,908.10	70.85	77.0	54.1920
180 per minute	135	770.15	15.643	3.80	22.182	17.965	5.02	100.334	6,270.87	7.13	41.83	1.22	50.18	314,672.40	74.28	80.7	54.1920
168 per minute	125	639.47	14.769	3.39	20.942	16.961	4.47	94.727	5,920.44	6.13	37.35	1.08	44.56	263,814.20	75.01	81.5	50.7590
170 per minute	133	665.83	14.854	3.43	21.063	17.059	4.52	95.275	5,954.69	6.28	38.22	1.09	45.59	271,474.30	74.14	80.6	51.1819
161 per minute[a]	132	569.33	14.017	3.05	19.875	16.097	4.03	89.902	5,618.88	5.73	34.46	.98	41.17	231,329.30	73.87	80.3	47.4115
180 per minute	187	754.83	15.294	3.64	21.687	17.564	4.80	98.095	6,130.94	6.86	41.03	1.16	49.05	300,721.20	70.79	76.9	54.1920
175 per minute	128	703.53	15.093	3.54	21.402	17.333	4.67	96.805	6,050.31	6.56	39.17	1.13	46.86	283,517.50	73.27	79.6	52.5660
Mean	....	716.39	15.148	3.56	21.480	17.396	4.71	97.158	6,072.41	6.64	39.72	1.14	47.50	288,517.90	73.06	79.4	52.8462

[a] These lines omitted from mean.

NOTE.—In the tests with different runners all conditions were as near the same in each case as possible. Diameter runner, 69 inches at tip of blades; 2 suction pipes 24½ inches inside diameter. Discharge pipe, 32 inches inside diameter, 1,000 feet long. Efficiency of pumps alone based on 92 per cent efficiency of engine.

TABLE No. 10.—*Testing dredges.*

[Data and results of main pump tests of dredges *Iota* and *Beta*.]

DREDGE IOTA.

Revolutions.	Steam pressure.	Vacuum, inches mercury.	Total indicated horsepower.	Suction pipes.		Discharge pipe.			Discharge per second.	Discharge per second.	Heads, feet of water.				Work done per second.	Efficiency of pumps and engine.	Efficiency of pump.	Peripheral velocity per second.	$\frac{\sqrt{2gh}}{V_p}$	Remarks.
				Mean velocity per second.	Velocity head of water.	Center velocity per second.	Mean velocity per second.	Velocity head of water.			Suction.	Delivery.	Velocity.	Total.						
	Lbs.			*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cub. ft.*	*Pounds.*					*Foot lbs.*	*P. ct.*	*P. ct.*	*Feet.*		
151 per minute..	155.0	23.0	667.69	16.016	3.99	18.60	17.181	4.59	100.131	6,258.19	9.74	26.55	0.60	36.89	230,864.63	62.9	72.4	49.4147	1.0181	500-foot pontons, open runner.
165 per minute..	150.0	24.8	817.83	16.622	4.29	19.40	17.920	4.99	104.438	6,527.38	10.71	31.75	.70	43.16	281,721.82	62.6	72.2	53.9963	1.0086	
165 per minute..	150.0	25.0	817.83	16.862	4.42	19.68	18.179	5.14	105.947	6,621.69	10.68	31.85	.72	43.25	286,388.08	63.7	73.3	53.9963	1.0090	
165 per minute..	150.0	25.0	817.83	16.751	4.36	19.55	18.059	5.07	105.248	6,578.00	10.77	31.80	.71	43.28	284,795.84	63.3	73.0	53.9963	1.0099	
168 per minute..	146.0	25.2	867.54	17.393	4.70	20.30	18.751	5.47	109.281	6,830.06	10.79	33.80	.77	45.36	309,711.52	64.9	74.0	54.978	1.0092	
168 per minute..	146.0	25.2	867.54	17.393	4.70	20.30	18.751	5.47	109.281	6,830.06	11.22	33.70	.77	45.69	312,065.44	65.4	74.6	54.978	1.0137	
166 per minute..	147.0	24.0	799.10	16.75	4.35	19.37	18.10	5.01	105.52	6,595.00	12.35	30.91	.66	43.92	289,652.40	65.9	71.6	54.824	....	Shrouded runner.
168 per minute..	155.0	24.0	823.49	19.85	6.12	22.65	21.30	7.05	124.18	7,761.25	12.48	31.16	.93	44.57	345,918.91	76.4	83.0	54.978	....	
168 per minute..	153.0	24.0	800.82	19.45	5.86	22.20	20.90	6.77	121.85	7,615.44	12.41	30.96	.91	44.28	337,211.57	76.1	82.7	54.978	....	

DREDGE BETA.

Revolutions.	Steam pressure.	Vacuum, inches mercury.	Total indicated horsepower.	Suction pipes: Mean velocity per second.	Suction pipes: Velocity head of water.	Discharge pipe: Center velocity per second.	Discharge pipe: Mean velocity per second.	Discharge pipe: Velocity head of water.	Discharge per second.	Discharge per second.	Heads: Suction.	Heads: Delivery.	Heads: Velocity.	Heads: Total.	Work done per second.	Efficiency of pumps and engine.	Efficiency of pump.	Peripheral velocity per second.	$\frac{\sqrt{2gh}}{V_p}$	Remarks.
129 per minute..	150.0	......	....	19.71	6.03	21.79	20.27	6.38	122.23	7,639.38	10.72	24.58	0.35	35.65	272,343.90	......	......	47.2811	....	600-foot pontons.
126 per minute..	147.5	......	881.75	18.79	5.48	20.77	19.32	5.80	116.50	7,281.25	10.59	23.89	.32	34.80	253,387.50	52.2	56.7	46.1815	....	
127 per minute..	147.5	......	882.19	19.35	5.81	21.39	19.90	6.15	120.00	7,500.00	10.53	24.14	.34	35.01	262,575.00	54.1	58.8	46.5477	....	
129 per minute..	150.0	......	930.18	19.87	6.13	21.79	20.27	6.38	122.23	7,639.38	10.62	24.76	.25	35.63	272,191.11	53.2	57.8	47.2811	....	
182 per minute..	145.0	......	1,018.30	20.23	6.35	22.36	20.80	6.72	125.42	7,838.75	11.36	27.01	.37	38.74	303,673.18	54.2	58.8	48.3806	....	
130 per minute..	142.5	......	962.97	19.87	6.13	21.97	20.43	6.48	123.19	7,699.38	11.21	26.51	.35	38.07	293,115.40	55.3	60.1	47.6477	....	
136 per minute..	....	......	1,102.47	20.91	6.79	23.12	21.50	7.18	129.65	8,103.18	12.42	28.77	.39	41.58	336,928.15	55.5	60.3	49.8467	....	
117 per minute..	155.0	......	743.15	17.63	4.81	19.49	18.13	5.10	109.82	6,832.50	9.59	20.66	.29	30.54	208,664.55	51.5	55.9	42.8828	....	
120 per minute..	152.0	......	777.74	18.23	5.16	20.16	18.75	5.46	113.06	7,066.25	9.65	20.37	.30	30.32	214,248.71	50.7	55.1	43.9824	....	

Dredge *Beta*.—Inside diameter of suction pipes, 33¾ inches; area=6.2 square feet. Inside diameter of discharge pipe, 33¼ inches; area=6.03 square feet. Diameter of pump runner, 84 inches. The runner is open, with 8 blades of the Rankine type. (See plate 85.)

APPENDIX 1 E.

SPECIFICATIONS FOR THE CONSTRUCTION OF SELF-PROPELLING HYDRAULIC DREDGE B. M. HARROD FOR THE MISSISSIPPI RIVER COMMISSION.

DETAILED SPECIFICATIONS.

52. Description.—This dredge is designed to have a single sand-pumping outfit, and also to be self-propelling. The hull will be of steel throughout, with guards extending to the outside of wheelhouses, and a well or opening at the bow in which the suction head is located. There will be a bridge or towing head across the forward end of well, and sheer legs will be provided on each side of the well for handling and setting the hydraulic piles. The pumping machinery will consist of a 36-inch centrifugal pump, driven by a pair of horizontal tandem compound engines. The sand agitator will be of the water jet type, supplied with water at about 20 pounds pressure, from a 20-inch centrifugal pump, driven by a vertical compound engine. The feeding into cut will be done by wire rope haulage and the dredge will be operated both up and down stream, the suction head being of special construction for this purpose. The propelling engines will be of the horizontal cross-compound type and will be coupled to the paddle wheels by spur gearing of about 5 to 1 ratio. All engines, as far as practicable, will be condensing, and the condenser will be of the ordinary marine surface type with independent air and circulating pumps. The steam plant will consist of nine Mississippi River 5-flued boilers, arranged in three batteries. The dredge will be fitted with auxiliary machinery for electric lighting, ice making and refrigeration, and with steam capstans, steam-steering gear, small machine shop, and sundry steam pumps; and will be outfitted in accordance with the requirements of the Board of Supervising Inspectors of Steam Vessels.

The pipe line will consist of five sections of 36-inch pipe, each section to be 100 feet long, and to be carried on two pontons and all coupled together by means of ball and socket joints.

53. Drawings.—The drawings furnished by the United States are those prepared in the office of the secretary of the Mississippi River Commission, and are indexed and catalogued as $\frac{\text{M.R.C.}}{1081}$, with numbers and titles as follows:

No. 1, longitudinal section; No. 2, main-deck plan; No. 3, cabin-deck plan; No. 4, cross section at engine room; No. 5, cross section at boiler room; No. 6, hull, plan and section; No. 7, details of hull; No. 8, main sand pump; No. 9, suction heads; No. 10, radial joints; No. 11, hoisting frame and pile derricks; No. 12, cable-hauling winches; No. 13, hoisting winch; No. 14, steam spud-lift and hydraulic piles; No. 15, ponton pipe line; No. 16, end elevations; No. 17, lines of hull. These drawings are general in character with the exception of a few details and sheets 8, 9, 10, and 15, which are full detailed drawings of the parts represented. It is the intention to give the contractor such freedom of design in matters of detail as will permit of the use of existing patterns and his ordinary methods of shop practice, provided they are suitable for the purposes intended, that they fully meet the spirit and intention of these specifications, that they comply with conditions clearly defined, and have the approval and sanction of the engineer officer in charge.

HULL.

54. Dimensions.—Length between perpendiculars, 210 feet; beam molded, 44 feet; total width over guards, 79 feet; depth molded, 8 feet 6 inches; depth at center line, 9 feet 3 inches; width at bow molded, 44 feet; width at stern molded, 34 feet; length of suction well, 35 feet; width of well at forward end, 33 feet; width of well at after end, 22 feet.

55. Framing.—The hull will be framed transversely and will be stiffened by four longitudinal and six transverse bulkheads. The knuckles will have a radius of 36 inches, modified at the bow and stern as required to suit the lines. The floors, from 27 to 104, inclusive, will be of 5 by $\frac{3}{8}$ inch Z-bars, 38 feet long in the full body, diminishing toward the stern as required. The frames will be of 4 by 3 by $\frac{3}{8}$ inch angle bar, overlapping the floors not less than 2 feet. Forward of 27 the frames in the wings will be of the same scantling, will butt on the center line and be secured by reverse clips of 3 by 3 by $\frac{3}{8}$ inch angles about 3 feet long. The rake forward of 27 will be framed longitudinally with 4 by 3 by $\frac{3}{8}$ inch angles and $\frac{3}{8}$-inch gusset plates where they can be applied without interfering with the radial joints. The frame spacing will be 24 inches throughout.

56. Deck beams.—All deck beams will be of 5 by $\frac{3}{8}$ inch Z-bars, spaced one to each frame except where otherwise indicated on the drawing. Each beam will be attached to its frame by $\frac{5}{16}$-inch gusset plates 18 by 20 inches, except where extra stiffening is required, when they will be $\frac{3}{8}$ inch in thickness, flanged on the free edge, and of the size indicated on the drawings.

57. Transverse bulkheads.—These will be located on frames 19, 32, 47, 64, 75, and 88, respectively. They will be framed with single 4 by 3 by $\frac{3}{8}$ inch angles at bottom and sides, and with double 3 by 3 by $\frac{3}{8}$ inch angles at top. The bulkheads will be of 10.2 pound plate with double riveted lap joints and stiffened with vertical bars of 3 by 3 by $\frac{5}{16}$ inch angles, spaced and arranged as shown on the drawings. All transverse bulkheads must be made water-tight, and where bulkheads are perforated for pipes or other connections, suitable flanges or packing boxes must be provided to insure the water-tightness of the bulkheads at all such places.

58. Longitudinal bulkheads and trusses.—The side plating of well will be continued to bulkhead 32, where it will join the outboard longitudinal bulkheads which extend aft to the transom. These bulkheads will be of 12.75 pound plate as far aft as bulkhead 88; the remainder will be of 10.2 pound plate. These bulkheads will have double 3 by 3 by $\frac{3}{8}$ inch angles both top and bottom, and will be riveted to every floor and deck beam at each crossing; in addition to which fastening there will be a clip of 3 by 3 by $\frac{3}{8}$ inch angle also riveted to every floor and deck beam. The longitudinal bulkheads will be connected to the transverse bulkheads by double 3 by 3 by $\frac{3}{8}$ inch angles and also by horizontal gussets of $\frac{5}{16}$-inch plate with 3 by 3 by $\frac{3}{8}$ inch angle clips. The bulkheads will be stiffened with vertical bars of 3 by 3 by $\frac{5}{16}$ inch angles, spaced and arranged as shown on the drawings or as special requirements of construction may require. The inboard longitudinal bulkheads, or trusses will be full plated between end of well and bulkhead 47, the remaining part being of latticed construction. The forward ends will be built of the same scantling and in substantially the same manner as described above for the outboard bulkheads, but subject to special treatment for engine foundations or other interferences. The after or latticed parts will be worked in between the transverse bulkheads, and will be attached thereto by both vertical and horizontal gussets and clips similar to those described for the bulkheads. The top and bottom chords will consist of two 3 by 3 by $\frac{3}{8}$ inch angle bars and a $\frac{5}{16}$-inch plate 11 inches wide, and the lattice bars will be of 3 by 3 by $\frac{5}{16}$ inch angles, made in double panels, with three rivets in each landing and riveted together at the crossings with a $\frac{5}{16}$-inch filling washer between.

From frame 27 to bulkhead 88, intercostal Z-bars will be fitted between the longitudinal bulkheads and the skin and deck plating. These intercostals will be 17 inches long, of the same scantling as the floor and deck beams, and secured by four rivets in each flange. Forward of 27 these intercostals will be continued under the deck to the well, and aft of 88 they will be placed where required for the proper strengthening of the deck to support the machinery.

59. Gunwales.—The gunwales will be of 4 by 4 by $\frac{7}{16}$ inch angle, running on the inside of plating.

60. Hull plating.—The plating of hull will be of 12.75-pound plate, except the sheer strake from frame 26 to frame 80, which will be of 15.3-pound plate. The ruling length of plates will be 18 feet. The knuckle will have a radius of 36 inches. The bottom will be in 11 strakes and the sides in 2 strakes, all as shown in cross sections on drawings 4 and 5. All longitudinal seams will be lapped and single riveted, and all girth seams will be butted, with single straps double riveted. All butts will be planed and fitted close, metal to metal; butt straps to be $\frac{3}{8}$ inch thick for $\frac{5}{16}$-inch plates and $\frac{7}{16}$ inch thick for $\frac{3}{8}$-inch plates. The longitudinal seams will be made by creasing the edge of one plate to a depth equal to the thickness of the plate to which it is joined, as shown in the full-size section on drawing 4; all plates will then be in close contact with the frames, and fillers will not be required. The creasing must be done in a first-class and mechanical manner, and without heating of plates.

The bow plate at after end of well will be $\frac{5}{8}$ inch in thickness, and if made in pieces will be riveted together with double butt straps double riveted. The lower edge must be accurately flanged, as shown, to receive the rake plates below the line of the radial joints. The connection between the rake plates and sides of well will be made with 5 by 5 by $\frac{1}{2}$ inch angles double riveted to each.

61. Deck plating.—The deck will be of 12.75-pound plate throughout, and will be in 13 strakes, the ruling length of plates to be 18 feet. The deck plates will project $2\frac{1}{2}$ inches beyond the gunwale from frame 12 to the forward wheel beam and from the after wheel beam to the transom. The longitudinal seams will be lapped and single riveted, the midline strake being an outside strake and the other strakes lapping right and left from the center. Parallel fillers will be placed under the midline strake, and taper fillers reaching beyond the first rivet from the lap, under all other strakes. The cross seams will be butted, with single straps, double riveted; all butts to be planed and fitted close, metal to metal. Butt straps will be $\frac{3}{8}$-inch in thickness. The crown of deck must be made strictly in accordance with the drawings, in order that complete drainage may be insured, and all plates used for the deck must be rerolled until all buckles and irregularities are removed and the plates are made perfectly straight.

62. Guards and nosing.—The guards will spring from frame 12 and will run aft to transom. The outriggers will have top chords 4 by 2½ inch by 7.3 pound T bars and bottom chords of 2½ by 2½ by 5/16 inch angles, connected by vertical struts of 2 by 2 by ¼-inch angles flattened at the ends to take two rivets, as shown on drawing 7. The outriggers will be attached to hull and guard rim at every second frame by ¼-inch gusset plates and clips, as shown on drawing. On the bottom edge of outriggers there will be riveted a continuous tie bar 3 by ⅜ inch. The guard rim will be of 12-inch by 20.5-pound channels, to the outboard face of which will be riveted the steel nosing. This nosing will be of corrugated plate 12 3/16 by 2¾ by ⅜ inch Carnegie's section M 33. The terminating ends shall be neatly worked to a semicircle and the whole substantially riveted to the guard rim with countersunk rivets flush on the outside.

The decking of guards will be of 7.65-pound plate, the plates to be laid transversely and butt jointed on the center of each outrigger; the inboard edges will be riveted to the underside of the projecting deck plates, and the outboard edges to the guard rim. The butt joints will be planed and fitted close, metal to metal, and all seams will be single riveted. All plates used for this decking must be rerolled until all buckles and irregularities are removed and the plates are made perfectly straight.

63. Limbers and deck scuppers.—Limber holes ¾-inch wide and 2½ inches long will be cut in floor beams as near the bottom flange as possible, and also in all places throughout the vessel where water can accumulate. The guards will be provided with drain scuppers of the form and size shown on drawing 4 and placed where indicated on the drawings, or in such other places as may be deemed necessary.

64. Riveting, etc.—All rivets will be of soft steel, ⅝-inch in diameter in general throughout the hull, except where otherwise specified or noted on drawings, or the nature of the work requires a different size. The rivets in seams and butts of outside plating will be spaced not more than 2½ inches apart center to center, and rivets of inside water-tight work will be spaced not more than 2¾ inches centers. All double riveting in hull will be chain fashion except where otherwise indicated on drawings. The distance between rows for double riveting and ⅝-inch rivets will be not less than 1⅝ inches; no rivet to be nearer to the seam, butt, or edge of plate or angle bar than its own diameter. The spacing of rivets in beam knees will be from 2¾ to 3¼ inches, but no beam knee will be secured with less than four rivets on each fastening. Rivets for securing outside plating to floors and frames, stiffening angles to bulkheads, and for all work where angle bars do not require to be calked, will be spaced not more than 5 inches centers. Heavy drifting must not be resorted to, and holes not punched fair must be reamed fair and a size of rivet to fill the hole must be used. Countersinks must be not less in depth than three-fourths the thickness of the plate or bar to be countersunk. Rivets must completely fill their holes, and the heads must be laid up in all water-tight work. Points of rivets on the hull may be slightly convex, but on the deck they must be chipped and made exactly flush. Rivets not filling their countersinks will be rejected.

65. Wheel beams, bridgetrees, etc.—The wheel beams will be built over bulkheads 47 and 64 and will project 16 feet 6 inches from the hull. The top and bottom chords will be of 12-inch by 25-pound channels connected by ⅜-inch plates at both inboard and outboard ends, and by lattice bracing in the middle. The lattice bars will be of 2½ by 2½ by 5/16 inch angles laid diagonally, and secured by two rivets in each end. The outer ends of wheel beams will be substantially connected to the outboard bridgetrees, which will be built in accordance with detail drawing No. 7. The bottom chords of these bridgetrees will be box girders consisting of two 12-inch by 20.5-pound channels with ¼-inch plate on top and tie plates and lattice bars on bottom. The top chords will be straight for a sufficient distance to receive the paddle shaft bearing and will then slope downward to meet the top of wheel beams. The top chords will be of 10-inch by 25-pound channels; web plates ⅜ inch thick and of the sizes and forms shown on drawing, will be riveted to top and bottom chords, and the whole will be braced by angle bars and brackets, as shown. All butt joints will be made with double straps ¼ inch thick, double-riveted. The inboard bridgetrees will be box girders and will spring from the deck, to which they will be secured by 4 by 4 by ⅜ inch angles. The bridgetrees will be in general of the form and dimensions indicated on drawing No. 7, but may be modified to suit the requirements of the engines supplied by the contractor. These bridgetrees must be made in a thoroughly substantial manner and the workmanship must be first class in every respect. They will be securely connected to the wheel beams, have a substantial back brace, as shown, be finished with snap-headed rivets on all outside work, and have all edges neatly dressed. Sole plates of cast steel with machined faces will be riveted to the top chords to receive the shaft bearings; all sole plates to have keying lugs cast on for the adjustment and securing of the bearings.

66. *Wheel and guard chains.*—The outer ends of wheel beams will be supported by eyebars, 2 inches diameter, coupled at the top end of struts to tie bars of the same diameter, which will be coupled together in the center by 2½-inch turnbuckles. The struts will be made of two 8-inch by 11.25-pound channels, reenforced at the ends and pin connected to the wheel beams as shown. The guards will also be supported by chains at intervals shown on the general plan, drawing No. 2. The rods will be 1¼ inches diameter with 1½-inch turnbuckles, and the tie rods will be 2 by ⅝ inch flat bars coupled with splice plates at the center, and will rest on top of the stringers. The struts will be of 4-inch extra strong pipe with cast-steel ends turned to a driving fit for the inside of pipe, and pin connected, as shown on drawing No. 4.

67. *Stanchions and bracing.*—Stanchions of 6-inch by 8-pound channels will be placed under alternate deck beams in the wings at each side of well; and all other stanchions and bracing that may be required or found necessary for the adequate support of the machinery under either standing or running conditions must be supplied and put in place by the contractor to the satisfaction of the engineer officer in charge, even though not specifically called for by the specifications or the drawings.

68. *Foundations for machinery.*—The foundations shown on the drawings are intended to be suggestive only, as they will necessarily be made to conform to the requirements of the machinery supplied by the contractor. They must not, however, be made of less scantling than indicated on the drawings, and must be built in all respects to the satisfaction of the engineer officer in charge.

69. *Foundations for boilers.*—The requisite beams for carrying the boilers will be built athwart the deck, as shown on drawing No. 5. They must be made to fit the irregularities of the deck either by suitable flanging or by properly tapered fillers, and must be adequately riveted down. The ash pans and troughs will be independent for each battery, the center trough to discharge through an ash tube extending from the bottom plating to the deck, and made water-tight throughout. The wing batteries will discharge on the outboard ends and through the guards. Stanchions of 8-inch by 11.25-pound channel to be placed under boiler beam, as shown on drawing No. 5.

70. *Discharge pipe in hold.*—The discharge pipe will be 36 inches inside diameter and made of 12.75-pound plate; the courses will be tapered, all seams lapped and single riveted, with heads countersunk and driven flush on the inside, and made absolutely water-tight. The pipe will pass freely through bulkheads 64, 75, and 88; each bulkhead will be provided with a flange riveted thereto, and will be run in with lead around the pipe to make a bearing and a water-tight joint. The after end section of pipe will pass through the transom and project 4 feet 6 inches beyond same, and will be secured in place by a 4 by 3 by ⅜ inch angle ring riveted to both pipe and transom. The discharge pipe will terminate with a ball similar in all respects to those used for ponton pipes and shown on drawing No. 15. The section of pipe from pump to bulkhead 47 will be removable, and is described in paragraph 159.

71. *Spud well, etc.*—This well will be located at 12 feet distance aft of end of suction well and alongside of longitudinal bulkhead, which will form one side of the well. The well will be made of 12.75-pound plate and 3 by 3 by ⅜ inch angles. Heavy steel mouthpieces will be riveted at top and bottom, as shown on drawing No. 7 and in detail on No. 14. The deck must be amply strengthened under the top mouthpiece, and provision must be made for carrying the base plate for lifting cylinder, as shown.

72. *Bow girder.*—A box girder will be built between the wings at bow of dredge; this girder will be 36 inches wide and 33 inches deep at center, with the same camber as the deck. The top will be of 12.75-pound plate, the sides of 10.2-pound plate, the top angles 3 by 3 by ⅜ inches, and the bottom angles 4 by 4 by $\frac{7}{16}$ inches; the girder will be stiffened by 9 ties of 10.2-pound plate, flanged on the bottom edge and connected by 2½ by 2½ by $\frac{5}{16}$ inch angle clips. The girder will be well secured to the hull by 4 by 4 by $\frac{7}{16}$ inch clips. The top plate will extend outboard to the gunwale of hull, forming a doubling plate on the deck, and $\frac{5}{16}$-inch cover plates will be double riveted over the connections on the forward face.

73. *Deck fittings.*—The following fittings will be placed on deck in approximately the positions shown on the general plan, drawing No. 2. They must be set on stiffening plates, which will be riveted independently to the deck and deck beams; and all fittings, as far as possible and where desirable, will be secured by riveting; 2 stack knees, shown in detail on drawing No. 7, for bow girders; 4 similar stack knees for each side of boat, on the guards; 4 large cast-iron mooring bitts, about 11 inches in

diameter and 24 inches high; 12 smaller cast-iron bitts about 7 inches in diameter and 16 inches high; 8 double-sheave chocks with sheaves about 9 inches in diameter and 3 inches wide; 4 cast-iron cavels about 3 feet 6 inches long, and such ring bolts, U bolts, or other fastenings as may be required for snatch blocks, etc., and necessary for the proper handling of the dredge in all its operations.

74. Fair leads for hauling cables.—Two pairs of fair leads, with sheaves 30 inches in diameter, for 1⅛-inch diameter wire rope, will be placed on bow of dredge. The sheaves will be bushed with bronze. Guide plates will be provided, flush with the inside of groove, and also proper protection to prevent the rope from jumping the sheaves, and strong crossbar on top to carry the ends of spindles.

75. Hatches.—All hatchways that are required to give access to the several compartments of the hold will be cut in the deck as shown on drawings or as may be directed. They will be provided with coamings, suitable covers, gratings of wrought-iron bars, and iron ladders, all to the satisfaction of the engineer officer in charge.

76. Rudders.—There will be two balanced rudders, the stocks to be of 10-inch tube ⅝ inch thick, and the blades a single plate ⅝ inch thick. The tubes will be slotted for a distance of 42 inches up from the end, the blades notched to receive the tubes for the remaining distance of 9 inches, and tubes and blades fastened together by 4 by 4 by $\frac{7}{16}$ inch angles, double riveted, as shown on drawing 7. The rudder-stock bearings will be steel castings riveted to the hull plating and having stuffing boxes at the upper end, with cast-iron packing glands. At the lower end of bearing a flange will be cast on, to which the bustle plate will be riveted as shown. On deck there will be bearings of cast iron with oil rim cast on; bearing collars of steel, fitting tightly into recesses turned in the heads of stocks, will be bolted on in halves and will run on bronze friction rings of proper thickness to give a minimum of clearance between the rudder blade and bustle plate. All rivets under water will be countersunk and driven flush, and all bumpers and other fittings necessary must be supplied. The tillers will be made as shown on drawing No. 7, and pin connected to rudder stocks, reenforcing bands to be riveted on the inside of stocks to give the necessary amount of bearing surface. Tiller tracks, with stanchions for same, will be secured between the longitudinal bulkheads as shown.

77. Connections for hoisting frame, etc.—All the deck fixtures necessary for carrying the several members of the hoisting frame and sheers will be made in accordance with details on drawing No. 11, and securely riveted to the deck in the positions indicated. Any extra strengthening of deck or deck beams that may be required must be supplied.

78. Traveling cranes.—The track beams for traveler will extend from the bulkhead at the forward end to the bulkhead at the after end of the engine room. The beams will be carried on posts made from two 8-inch by 11.25-pound channels latticed together, the outboard channel being extended upward to carry the cross beams on which the boiler deck stringers will rest, as shown on drawing No. 4. The traveler will consist of two I beams of sufficient strength to carry the heaviest single piece that will require removing for overhauling and repairs, and will be fitted with hand-chain traversing gear. Two carriages will be provided to run on the inside flanges of beams, each fitted with shackles from which will be hung chain blocks of sufficient power to meet the requirements above stated. It is contemplated that both tackles will be used for lifting the pump shaft and runner, or any other heavy weight to which the two can be applied. A similar traveler, but with one carriage and of smaller capacity, will be built athwartship over the winches on the forward deck. This will be of sufficient strength to lift the hauling drum and gear wheel. All framing will be efficiently braced in such a manner as not to interfere with the machinery or gangways. The boiler-deck beams will consist of two 6-inch by 8-pound channels, bolted together, with yellow pine filling between, curved to suit the crown of deck, trussed as indicated on the drawing, and connected to the posts by ¼-inch gusset plates. Four posts of 6-inch by 8-pound channels will be secured to the two forward beams in engine room, to which the corner posts of pilot house will be bolted.

79. Sheer legs at stern.—A pair of sheer legs will be provided and set up at the stern of the dredge, of ample strength and reach to lift the short junction pipe which makes the connection to the pipe line. The legs will be made from heavy pipe, with solid forged or cast steel ends, pin connected top and bottom. All necessary wire rope guys, shackles, etc., will be provided; also extra shoes for setting sheers to each side of the central position.

80. Material.—The hull will be built entirely of steel. All plates, angles, and shapes will be of medium steel, having an ultimate tensile strength of from 60,000 to 68,000 pounds per square inch, the elastic limit to be not less than one-half the ultimate strength and the elongation to be not less than 22 per cent in 8 inches. One test piece for tensile strength and one for bending will be taken from the steel of each heat. For the bending test the pieces must bend cold 180°, to a diameter equal to the thickness of the piece tested, without fracture on the outside of the bent portion. A variation of more than 2½ per cent above or below the specified weights for any material will be cause for its rejection. Rivets will be tested cold by driving the shank into the head, under which treatment the material shall be without sign of fracture on the outside edge. Facilities must be given to the inspectors by the manufacturers and contractor for making all tests, the cost of which, except the salary and traveling expenses of the inspectors, will be borne by the contractor.

81. Testing of hull.—The bottom of hull will be tested for water-tightness before launching, by filling with water to a depth of about 6 inches, and all leaks and imperfections then discovered will be made good at once. The testing must be done under the direction and to the satisfaction of the engineer officer in charge or his representative, and will be extended to include a test of the water-tight bulkheads in such a manner as may be considered expedient at the time of testing.

82. Cementing of hull.—The rakes of vessel inside, and all places where water can lodge, will be filled with cement to a height necessary to run the water through the limber holes. The gutters formed by the laps of plates will be filled with cement throughout the whole bottom of the vessel. The cement will be composed of one part of fine, clean, sharp-grained river sand to one part of best quality of Portland cement, thoroughly mixed and neatly and carefully laid. The cementing shall not be put in until such time after launching as the engineer officer in charge will direct, and not until the hold has been made perfectly clean and suitable for the purpose.

83. Draft marks.—The draft of water for 4 feet, 5 feet, and 6 feet will be neatly marked with a center punch and painted in white. These marks will be put on each side of the hull, abreast of the heel of rakes both fore and aft, and also on each side of the well.

UPPER WORKS.

84. Material.—All lumber used in the construction of the upper works and in all other carpenter work must be first class in all respects, clear and well seasoned, free from sap and shakes, cross grain, large or loose knots, or other defects impairing its suitability for the purpose intended, properly milled, dressed on sides and edges, and must be of the sizes specified after dressing. Where oak is specified, nothing but upland white oak will be accepted.

85. Deck houses.—These houses will be substantially of the dimensions and form shown on general plan No. 2, but subject to modification if found necessary by the contractor in order to accommodate the machinery he supplies. The engine room will extend from 15 feet aft of the suction well to frame 63, the boiler room thence to frame 92, and the machine shop thence to frame 99.

86. Framing.—A coaming of oak, 5¾ inches wide and 3¾ inches deep, will be securely bolted to the deck to receive the stanchions. This coaming will be properly fitted over laps in the deck, and will be laid on a layer of tarred sheathing felt and made thoroughly water tight. The main stanchions of the deck house will be of oak, 3¾ by 3¾ inches, secured by angle brackets of cast iron, through bolted as shown in detail drawing No. 4 and spaced about 8 feet apart. The intermediate stanchions will be of yellow pine, 1¾ by 3¾ inches, checked and nailed to coaming and spaced about 24 inches apart.

87. Clamps.—The heads of stanchions will be secured by clamps, the inside clamps to be of oak 1⅝ by 10 inches and the outside clamps of yellow pine 1¾ by 12 inches. The inside clamp will be checked 1 inch into all stanchions and through bolted with ⅝-inch carriage bolts. Clamps will be in long lengths, with scarfs 30 inches long.

88. Carlins.—Carlins for boiler deck will be of yellow pine 1⅝ by 5½ inches, spaced about 20 inches apart and curved to a crown of 9 inches between lines 22 feet on each side of the central line of the boat. Beyond these lines the outer ends will be continued straight. The carlins may be in three pieces, lap-jointed over stringers and well nailed together. Carlins will rest on inside clamps and be checked 1 inch into the outside clamps.

89. Stringers.—The stringers will be of yellow pine 5½ by 9½ inches, arranged as shown on the drawings and bolted to their crossbeams, stanchions, or trusses, as required. They will be of long timber, scarfed not less than 3 feet and well bolted together.

90. Stanchions and trusses.—All stanchions for stringers other than those in framing of houses are to be of 3½-inch pipe, secured at top and bottom by cast-iron flanges. Over the boilers the boiler-deck stringers will be carried by pipe stanchions and angle-bar trusses in accordance with drawing No. 5. The chimneys will be supported by a framing of 6-inch by 12.25-pound I beams, riveted together and carried by boiler-deck stringers trussed as shown on drawing. Any supplemental stanchions that may be found necessary for the proper support of the cabin or for any other purpose are to be provided by the contractor, whether indicated on the drawings or not.

91. Boiler deck.—The deck will be laid with yellow pine ⅞-inch thick by 3¼-inch face, tongued and grooved, and beaded on the under side. The height of boiler deck from main deck will be 15 feet 6 inches, measured at the center and at each side of hull. The guards will project beyond the deck houses, as shown on the drawing, and will be finished with a waterway of yellow pine 1¾ by 3¾ inches, facing of oak ⅞ by 6 inches, and nosing of oak ⅞ by 5 inches. The boiler deck will be doubled over the intermediate section of cabin, which contains the kitchen, crew's mess room, laundry, etc. The second course will be ⅞ inch thick and 3¼ inches wide, slightly outgauged, well calked with cotton, and payed with thick white lead. All decking will be secret and double nailed and put together with thick white lead in the joints.

92. Siding and partitions.—All deck houses will be sided with ⅞-inch yellow pine 3¼ inches wide, tongued and grooved, and beaded both sides, and will be laid horizontally, except at round corners, where it will be vertical. A row of transom sash will be placed below the clamps, and all doors, windows, and shutters that are indicated on the drawings, or that may be required for the proper lighting and convenient operating of the dredge, are to be put in.

93. Skylights.—Two A skylights about 4 feet wide and 10 feet long will be built on the boiler deck for lighting the engine room between the wheelhouses. The hatch coamings will be 15 inches high on the inboard side, and the covers will be very strongly framed, provided with water grooves and fitted with heavy brass hinges, quadrants, lifters, and fasteners.

94. Bunkers.—The coal bunkers will be made as shown on general drawing No. 2. The bulkhead will be sided on both sides and made dust-tight; the boiler-room side will be sheathed for a height of 6 feet from deck with 1¼-inch yellow pine flooring. Gangways 4 feet 6 inches wide, from engine room to guards abaft the wheelhouses, will be built on each side, as indicated on drawing.

95. Machine shop.—This will be aft of boilers, of the size and form shown, and will be built in the same manner as the engine room.

96. Crew's lavatories.—Lavatories will be provided at the after part of main deck, as indicated on the drawings, or as may be directed by the engineer officer in charge.

97. Lockers, etc.—The engine room and machine shop are to be amply provided with lockers, bolt boxes, tool and spanner racks, vise benches, and other fixtures requisite for engine room and ship stores, to the satisfaction of the engineer officer in charge. The more important only of these fittings are indicated on the drawings, but it will be understood that the vessel is to be thoroughly outfitted in this respect.

98. Stairways.—There will be two stairways on each side of the vessel from the guards to the boiler deck. They will be 30 inches wide between carriages, which will be of yellow pine 1¾ inches thick. The treads will be of hardwood 1⅛ by 10 inches. The stairs will be braced and provided with suitable hand railing.

99. Wheelhouses.—The wheelhouses will be built to the dimensions shown on drawings 4 and 5. They will be framed with stanchions of same scantling as used for the engine house. Fender stanchions of oak, 8 by 10 inches, are to be set at the outboard corners of wheelhouses and well braced. The top of wheelhouse above boiler deck is to be framed with rafters of oak 2 by 8 inches bolted to stanchions, upon which nailing strips of oak 2½ inches thick are to be secured, spaced 24 inches apart. The outside sheathing will be similar to that used for the deck houses, and will be doubled where necessary to make water-tight work. The forward and after end inside sheathing will be 1¼-inch yellow pine flooring as far as the boiler deck. The outboard face of wheelhouse will have a neat molding around the edge and will have the boiler-deck facing and nosing continued fore and aft. A grille with star or other neat device will be built about the shaft center. All ⅞-inch sheathing will be put together with thick white lead, and the whole of the inside of the wheelhouses will receive a coat of hot tar thoroughly applied.

100. Swinging fenders.—All swinging fenders will be of best quality white oak or hickory, without defect of any kind. The long fenders at wheelhouses will be 8 by 10 inches at bottom and 6 by 10 inches at top; the short fenders for side-stack knees will be 8 by 10 inches at bottom and 7 by 10 inches at top, and the fenders for bow-stack knees will be 9 by 12 inches at bottom and 7 by 10 inches at top. All fenders will be neatly dressed and shaped and properly lashed in place.

CABINS.

101. General description.—The general arrangement of the cabin is shown on drawing No. 3 and in the cross sections on drawings 4 and 5. At the forward end will be the office and spare staterooms, separated by a passageway 11 feet wide, through which the spud anchor passes. The saloon will be 38 feet long and will contain eight staterooms, bathroom, and lavatory. The intermediate section will be 56½ feet long and will contain kitchen, storeroom, crew's mess room, laundry, linen closet, and quarters for cooks, waiters, and laundress; also chimney hatch at the after end. The after section of cabins will be 43 feet long and will contain the crew's quarters and two bathrooms. There will be passageways between the several sections of the cabin, but the roof and the skylight will be continuous throughout.

102. Dimensions and material.—The plank sheers will be of yellow pine ⅞ by 3½ inches; cabin outside stanchions of poplar 1 by 3½ inches; inside stanchions of poplar 1¼ by 3 inches; outside clamps of white pine 1⅛ by 8 inches; inside clamps of white pine 1⅛ by 5 inches; carlins of poplar 1⅛ by 5½ inches; bulkhead strips of poplar 1 by 2½ inches; panels of poplar $\frac{5}{16}$ inch and margins of white pine ⅝ by 3 inches; roof facing of oak ⅞ by 5½ inches; nosing of oak ⅞ by 4 inches; waterway of white pine ⅞ by 3 inches. The skylight clamp will be of white pine 1⅛ by 9 inches; carlins of poplar 1⅛ by 5½ inches; facing of white pine ⅞ by 4 inches; nosing of white pine ⅞ by 3 inches, and waterway of white pine 1⅛ by 2 inches.

103. Forward cabin.—The height of cabin from the boiler deck will be 8 feet 6 inches on the midline and 8 feet at the sides. The carlins will be properly sawed to a crown of 17 inches in 44 feet and spaced about 20 inches apart, center to center. The skylight carlins will be crowned 9 inches in 17 feet and spaced 20 inches apart, center to center. All skylight carlins in forward cabin will be capped on the underside and finished with neat moldings on the ceiling. A box cornice will extend the full length of the skylight, neatly finished with suitable moldings, and in the forward cabin supported by brackets from heads of pilasters, which will be placed on each side of all stateroom doors.

All outside bulkheads will be built with panels and margins in the manner usual on Mississippi River steamboats. All joiner work will be done in a thoroughly good and substantial manner, and neatly but plainly finished. At the after end of saloon two store closets 5 feet wide and 2½ feet deep will be built, with panels and margins to match the interior of cabin, and fitted with four tiers of shelves of poplar ⅞ inch thick and ranging from 14 to 10 inches in width.

104. Intermediate section.—The kitchen and storerooms will be built with their stanchions in line with those of the saloon, and will be of the same width as the skylight. Abaft of the storerooms the house will widen out to 34 feet, same as the forward cabin, and will extend aft 19 feet to the chimney hatch, which will be 10 feet on the fore and aft line and the full width of the house. The athwartship bulkheads of chimney hatch and inside partitions will be of white pine ¾ by 3¼ inches, tongued and grooved and beaded on the outside, laid vertically; all the remaining parts of this section will be paneled same as the forward cabin. On the starboard side of mess room there will be three sleeping rooms, and on the port side will be located the laundry, linen closet, and laundress' room. The kitchen is to be fully fitted with tables, racks, shelves, cupboards, and drawers, and the storerooms and linen closet with all required shelving. The crew's mess room will be supplied with two tables 12 feet long and 3 feet wide, with pine frames and hard-wood tops, and eight seats, 6 feet long, to suit the same. The laundry will have an ironing table, stand for washtubs, shelves, racks, and hooks as required.

105. Ice box.—An ice box or refrigerator, about 30 by 50 inches by 6 feet high, will be located as shown. This must be of first-class and approved construction, charcoal filled, and provided with drain pipe, suitable galvanized-iron or brass fittings, and will be housed in with ¾ by 3¼ inch white-pine partition.

106. Hopper.—A hopper for kitchen refuse will be placed on the starboard wheelhouse siding, as shown, with hinged cover for same.

107. Crew's cabin.—A passageway 5 feet wide will run between chimney hatch and after cabin, which will be 38 feet long and 24 feet wide and will contain the crew's quarters. There will be a partition 8½ feet high running down the center, made of white pine or poplar, ¾ by 3¼ inches, tongued and grooved and beaded. The outside bulkheads will be paneled same as the forward cabin. Abaft the cabin there will be two bathrooms, each 5 by 8 feet, built in a manner similar to the remainder of cabin.

108. Skylight.—Over the office and forward staterooms the skylight will be 14 feet long, fore and aft, and 28 feet wide athwartship. From this it will extend aft continuously to the end of crew's cabin, with a width of 14 feet, as shown on drawings 4 and 5. The carlins will have a crown of 9 inches in 17 feet, and the roof will be laid with white pine, ⅞ by 3¼ inches, tongued and grooved and beaded on the underside. All strakes in roof will be double nailed to every carlin, and put together with thick white lead in the joints. The skylight will be provided with transom sash in the wings of forward end and throughout its length, except at boiler hatch, where louver boards will be substituted. Bulkheads will be extended to the roof of skylight at the various divisions of the cabin, and will be neatly paneled in keeping with the general character of the part with which they are connected. Open stretches of skylight not supported by bulkheads will have necessary stanchions and stringers to give the required strength.

109. Hurricane deck.—This deck will be laid with white pine ⅞ inch thick in strakes 3¼ inches wide, tongued and grooved and beaded on the underside. All strakes will be put together with thick white lead and will be double nailed to every carlin and finished with the usual waterway, facing and nosing as called for in paragraph 91. Stairway hatches will be provided as called for.

110. Guard rails.—The stanchions for guard rails will be of oak 1¾ by 1¾ inches, spaced 5 to 6 feet apart, with one short stanchion of white pine between. The rail will be 33 inches high, with cap of white pine ⅞ by 4 inches with rounded edges, oak filling ½ by 1¾ inches on each side, and two rails of oak ½ by 1¾ inches. The stanchions are to fit tightly into malleable-iron sockets and to be fastened by screws, the sockets being securely screwed to the deck after the canvas is laid. The upper ends of stanchions will pass through hurricane roof, and at a height of 18 inches above same will carry a rail of the same construction as specified above for the main rail.

111. Pilot house.—The pilot house will be 14 feet wide and 12 feet long fore and aft, built as shown on drawing 4. The corner posts will be of yellow pine 6 by 6 inches, and will rest upon the cross beams under the boiler deck and be bolted to 6-inch channels riveted to the cross beams to receive them. The house will be built with panels same as cabin and fitted with the usual adjustable sight shades in front and with sliding sashes on the other three sides. The sashes will be 1⅜ inches thick, mounted with rollers on brass water tables and held in place by oak guide strips. Approved sash fasteners will be provided. The floor will be of yellow pine same as used for boiler deck, joists of yellow pine 1⅜ by 9½ inches, carried on side rails 1¾ by 8 inches, well secured to stanchions. The roof will be of white pine same as used for skylight and will be finished with waterway, facing and nosing as shown on drawing. The interior will be neatly finished, the walls below the windows to be paneled, stanchions above windows boxed, and carlins fitted with moldings at roof line. A sash door 30 inches wide will be provided in after side of house, with suitable stairs and hand rail; also a batten door underneath the floor. The pilot house will be furnished with a steering wheel 10 feet in diameter, made in the best manner, with double rims of cherry, turned spokes, and barrel of locust, and mounted in the usual manner; tiller ropes ¾ inch diameter, with all requisite sheaves and sheave boxes, wheel brake, bell board, and such other fittings as are hereinafter specified will be provided and fitted in place.

112. Doors.—All doors will be of first quality white pine. The inside doors in forward staterooms will be 24 inches wide and 1⅛ inches thick, with raised panels one side; outside doors will be 24 inches wide and 1⅛ inches thick, upper part one-light sash, lower part raised panels one side; end doors of saloon will be 36 inches wide and 1⅜ inches thick, upper part four-light sash and lower part raised panels both sides. In the intermediate and after sections of cabin the doors will be of the sizes marked on the drawing and will conform in style and make to those described above. All staterooms, office, and crew's sleeping rooms will have blinds fitted to all outside doors; blinds to be white pine ⅞ inch thick, with stationary slats, made in pairs and rebated. The sash doors in bathrooms and water-closets will have lights of ground glass. There will be eight sliding doors on main deck, located as shown on drawing 2, or as may be hereafter determined. These doors will be in one or two parts as indicated, substantially framed of yellow pine, and sheathed with same material as used for siding of house, mounted on extra heavy warehouse hangers with 6-inch wheels and furnished with suitable guides and stops, heavy rim locks, and flush door handles. The other doors on main deck will be of the sizes given on drawing, the large doors to be 1⅜ inches in thickness, with sash in the upper part and raised panels both sides in the lower part; the smaller doors to be 1⅛ inches thick and of such size and make as may be suited to their locations.

113. Windows and transoms.—The sash for windows in rooms on boiler deck will be 1⅛ inches thick, made to drop on inside of bulkheads and fitted with slides and water tables, sash weights, pulleys, cords, and fastenings. The windows in office and forward staterooms will have outside blinds, also made to drop. The windows on main deck will be of the sizes given, the sash to be 1⅜ inches thick, made to drop on inside of bulkheads and fitted with slides and water tables, sash weights, pulleys, cords, and fastenings. The sash for skylight and transoms in staterooms will be 1 inch thick, those for skylights to be hung at the bottom, opening outward, and those for transoms to be hung from top, opening inward. The transom sash for main deck houses will be 1 inch thick, hung on center pivots. All glass used throughout the boat will be of finest quality, double thick "American," and sashes must in all cases be made to take lights of standard sizes without cutting.

114. Hardware.—All the hardware for this dredge is to be first class, and must be approved by the engineer officer in charge before being put on. All doors of rooms on boiler deck will be hung with brass loose-pin butts of a size proportionate to the size of door. All doors will be fitted with rim locks and white porcelain knobs, and with brass hooks of ship cabin pattern for fastening back. Door blinds will be fitted with extra heavy brass shutter bars and with brass hooks for fastening back. The doors on main deck will have large steel hinges and rim locks with black porcelain knobs of extra quality. The transom and skylight sash will be hung with brass hinges and have such hooks, buttons, chains, or other fasteners as may be required. All hardware required throughout the vessel to make the same complete and efficient, whether specifically mentioned in the specifications or not, must be provided and put in place by the contractor.

115. Stairs and steps.—There will be two stairways at the forward end and two at the after end of cabins, from the boiler deck to the hurricane deck. These will be located and built as shown on the drawings, treads to be hardwood 1⅜ by 9 inches with risers of ⅞-inch pine. Stairways will be sided up to hurricane deck where required. They will be provided with neat and suitable handrails and also with hatch doors, and railing around the wells on roof. Eight sets of steps to skylight roof will be provided and held in place by hooks fastened to nosing. These steps will be 24 inches wide outside, with treads of hardwood 1¼ inches thick tenoned into carriages.

116. Flag staffs.—Two flag staffs will be provided, of Michigan pine, perfectly straight, properly shaped, and fitted with sheave trucks, cleats, and halyards. The forward staff will be 5 by 5 inches at butt and 36 feet long, the after staff 5 by 5 inches at butt and 30 feet long, and both will be stepped on boiler deck and securely strapped and bolted to nosing.

117. Roof and deck covering.—The hurricane deck, skylight, roof, and pilot house roof will be covered with H. W. Johns-Manville Company's "Standard" asbestos roofing or other asbestos roofing of equal quality. This roofing will be carefully laid and the directions given by the manufacturers will be exactly followed. The boiler-deck guards and passageways outside of the cabins will be covered with 12-ounce cotton duck, United States Army standard, of approved make, put on in a thoroughly first-class workmanlike manner, well lapped at edges and secured with 10-ounce tinned tacks, laid on a thickness of heavy roofing felt and painted with three coats of pure white lead ground in pure boiled linseed oil and toned to lead color with lampblack.

118. Hose and fire-bucket racks.—Racks and boxes for the proper stowage of all fire hose are to be provided as required; also 6 fire-bucket racks, for 6 buckets each, to be placed on skylight roof as directed.

PLUMBING AND TINNING.

119. Quality of materials and workmanship.—All fixtures and materials are to be of the best quality of their respective kinds, and all work is to be done in a most thorough, sanitary, and workmanlike manner, to the full satisfaction of the engineer officer in charge; illustrations and descriptions of all fixtures and fittings must be submitted for approval before any fixtures are put in.

120. Lavatories.—Each of the four staterooms will be furnished with an enameled iron-corner lavatory with apron, 16 inches long on sides, with 11 by 14 inch oval basin, patent overflow with nickel-plated brass overflow strainer, waste plug, rubber stopper, and nickel-plated brass soap cup.

The officers' wash room will be furnished with a three-section enameled iron lavatory, each section 18 by 24 inches, with 12 by 15 inch oval basin, patent overflow, fitted with nickel-plated brass overflow strainer, waste plug with rubber stopper, 12-inch enameled back, nickel-plated brass union strips, nickel-plated brass soap cups and iron brackets.

The crew's quarters will be furnished with two four-section enameled iron lavatories, each section 18 by 24 inches, with 12 by 15 inch oval basin. These lavatories to be similar to those described above for the officers' wash room, and provided with similar fittings.

The engine room on main deck will be furnished with two enameled iron-corner lavatories, 16 inch sides, each having 11 by 14 inch oval basin, patent overflow, nickel plated brass overflow strainer, waste plug with rubber stopper, and nickel-plated soap cup.

All the above basins will be supplied with No. 4 nickel plated Fuller cocks for both hot and cold water. The supply and waste pipes will be of brass, iron pipe size, as far as the first connection below the deck. No traps will be required on the waste pipes. All pipes passing through decks will be fitted with deck plates, made water-tight.

The crew's wash room on main deck will be furnished with a trough, 15 inches wide and 8 feet long, zinc-lined and provided with drain pipe and wood cover, also with two hot and two cold water pipes with self-closing bibbs.

121. Bath tubs.—Three 5½-foot iron white enameled bath tubs with 3-inch roll rim will be placed in bath rooms as shown on plan. Each tub will be furnished with one No. 4½ nickel-plated Fuller double bath cock, nickel-plated brass supply pipes, and nickel-plated connected waste and overflow, with nickel-plated strainer and rubber stopper.

122. Water closets.—There will be three closets on boiler deck alongside the port wheelhouse, fitted with No. 2 front outlet plain pedestal bowls, copper-lined low flushing tanks, double-cover seats, and all fittings nickel plated. Seats and tanks will be of oak or birch, with plain round corners. The soil pipes will be connected and will discharge through wheelhouse bulkhead, with an elbow on the outside. All the drainage service will be of wrought pipe with screwed drainage fittings.

The crew's closets on main deck will be furnished with four iron flushing rim hoppers, enameled both inside and outside, each furnished with oak seat, extra large galvanized-iron flushing tank and all connections for same. The tanks will be supplied by the deck pump, and overflow pipes from tanks will connect with each hopper.

123. Sinks.—One iron white-enameled sink 40 by 20 inches for pantry, one 30 by 20 inches for kitchen, and one 30 by 20 inches for laundry, will be furnished and set in place. Sinks will have iron brackets, Fuller bibbs and galvanized pipe connections for hot and cold water and waste. The waste pipe from kitchen sink will be not less than 1½ inches in diameter and all wastes will be connected without traps and will be run overboard independently.

124. Pipe fitting.—All pipe fitting in connection with the plumbing must be done in a substantial, workmanlike, and sanitary manner. All rough edges must be removed from the inside of pipes; pipes must have the proper inclination for drainage and must be provided with brass drain plugs where necessary; screwed unions must be of brass and of heavy pattern and must be put in wherever necessary for the convenient disconnection of pipes and fixtures.

125. Down spouts.—The following down spouts will be provided: 4, 2 inches in diameter, from the pilot house roof to the skylight roof; 7 on each side, 2 inches in diameter, from the skylight roof to the hurricane deck; 7 on each side, 2½ inches in diameter, from the hurricane deck to the boiler deck; and 10 on each side, 3 inches in diameter, from the boiler deck to the main deck. All the above down spouts will be made of galvanized iron No. 22 U. S. G., properly set up with flanges well nailed to decks, and secured in place in a thoroughly substantial manner.

STEAM PLANT.

126. Main boilers.—There will be nine boilers of the ordinary Mississippi River type, set in three batteries of three boilers each, as shown on general plan and cross-section drawing No. 5. Each boiler will be 47 inches mean diameter and 28 feet long, and will have three flues 11 inches and two flues 12 inches in diameter. The boilers will be built in strict accordance with the rules of the Board of Supervising Inspectors of Steam Vessels, for a working pressure of 155 pounds per square inch. The shells will be of marine steel 0.30 inch in thickness and of from 62,000 to 67,000 pounds tensile strength. All holes will be drilled, and the longitudinal seams double-riveted and placed above the fire line. All flues will be lap welded and the material will be of such quality as will meet all the requirements of inspection and test. The 11-inch flues will be 0.22 inch thick and the 12-inch flues 0.24 inch thick. The flues will be made in sections 3 feet in length, with the joints carefully and tightly fitted into each other, the outside ends being carefully expanded for the purpose, and the rivet holes countersunk on the outside and the driven heads slightly and neatly rounded. The finished flues must be perfectly straight, seams staggered when flues are in place, and must be tested by hydrostatic pressure to 240 pounds per square inch before being put into the boilers. Each battery of boilers will have a steam drum 30 inches in diameter, with 10-inch connections to the shells; two mud drums 16 inches in diameter, with 8-inch connections, and chock pipes 6 inches in diameter at the rear ends. All connections must be made in such a manner as to retain the full strength of the material in the flange riveted to the shells, and all connections must be of ample section to compensate for the metal cut out for the holes. All heads of boilers and drums must be carefully annealed after flanging. The boilers will be fully equipped with steel branches riveted to the shells, to receive all fittings, and with all the usual and requisite man and mud holes in boilers and drums, fitted with doors and fastenings complete.

127. Boiler fronts, casing, and brick work.—The boilers will be provided with heavy cast-iron fronts made substantially as shown on drawing 5, fitted with all necessary fire, poker, and ash doors, mouthpieces, grate bars, and bearers. The casings will be of sheet steel No. 12 U. S. G., strengthened with angle-bar flange around the edge and carried by framing bars, stanchions, and cast-iron stools in a thoroughly substantial manner. All necessary braces, stays, soot doors, etc., will be provided. The boilers will be built in with the best quality of fire brick and covering tiles, the ash pans lined with splits, and the settings generally constructed in a thoroughly workmanlike manner to the satisfaction of the engineer officer in charge.

128. Breechings and chimneys.—Each battery will have an independent breeching and chimney. The breechings will be made of $\frac{3}{16}$-inch iron plate and 1¾ by 1¾ by ¼ inch angles, of the forms shown on the drawing, and built in a neat and workmanlike manner. The smoke doors will have flame plates $\frac{3}{16}$ inch thick inside and shields of No. 16 U. S. G. sheet outside, and all requisite hinges and fastenings. The breechings must be properly secured in place by bolts and heavy crossbars and connected with the chimneys by slip joints. The chimney stumps will be of iron plate $\frac{3}{16}$ inch thick, the upper ends finished with 2½ by 2½ by $\frac{5}{16}$ inch angle-bar flanges and the lower ends with a 2½ by ½ inch band. The stumps will have four angle brackets riveted near their lower ends, as shown, to carry the weight of the chimneys. The chimneys will be 42 inches in diameter and 70 feet in height above the grates, and will be made of iron sheets No. 10 U. S. G. for the lower half and No. 12 U. S. G. for the upper half. The chimneys will be neatly riveted with cup heads on the outside and strengthened by four 2 by 2 by ¼ inch angle bars running full length in the inside. They will be finished at top with bands and at bottom with flanges to mate the stumps. All eyebolts, wire rope, guys, braces between chimneys, turnbuckles, and fastenings required for securing the chimneys will be furnished and set up in a satisfactory manner. Brackets for carrying the signal lights will be riveted to the chimneys. The chimneys will be fitted with the usual casings, deck rings, and umbrellas, as indicated on drawings. The casings will be in two lengths connected by slip joints, the lower part resting on the chimney beams and the upper part carried from the hurricane deck. The casing will be of steel No. 14 U. S. G., the deck rings of No. 16 U. S. G., and the umbrellas of No. 14 U. S. G. All casings will be stiffened with bands or bars, and such fittings as may be required to make a complete and satisfactory piece of work must be supplied.

129. Chimney bearing frame.—This frame will consist of two 6-inch by 12.25 pounds I-beams, curved to the camber of the boiler deck and resting on the deck stringers, to which they will be secured by strap bolts. These beams will be about 4½ feet apart center to center, and on each side of each chimney a short beam of similar section will be riveted by means of corner gusset plates ¼ inch thick. The center span of the beams will be supported by trusses, as shown on the drawing.

130. Boiler fittings.—Each wing boiler will be furnished with three and the center boilers with two ¾-inch Mississippi gauge cocks, with hoods, troughs, and drainpipes of galvanized iron. A low-water gauge of approved make will be fitted to each boiler. Each battery of boilers will be furnished with one 6-inch spring loaded safety valve, two 7-inch steam stop valves, two 3-inch auxiliary steam stop valves, one 3-inch feed check valve, one 3-inch feed stop valve with internal pipes, two 2½-inch blow-off valves, and one 1½-inch surface blow-off valve for each boiler. The safety valves will have heavy cast-iron bodies, bronze mounted, with locks, and easing levers. They must be of approved make, and conform in all respects to the requirements of the rules of the Board of Supervising Inspectors of Steam Vessels. The steam stop valves will be "extra heavy" pattern, with outside screws and yokes. The feed valves and the blow-off valves will be "extra heavy," iron body, bronze mounted, with outside screws and yokes and of approved pattern. The check valves will be "extra heavy," swing pattern, iron body, bronze mounted, with covers secured by bolts. The surface blow-off cocks will be of bronze, "extra heavy" pattern, and fitted with internal pipes and scum dishes made of sheet brass. Fusible plugs will be inserted in flues and shells as prescribed by law. Ladders and run boards for giving access to valves will be furnished and set up as indicated.

131. Boiler covering.—All boilers, steam drums, and connections will be covered with genuine magnesia nonconductor, containing not less than 85 per cent of magnesia. The covering will be not less than 2 inches in thickness, put on in blocks, well secured by wiring or bands, and covered with No. 6 canvas, sewed on where practicable, and painted two coats of white paint. The covering tiles of main boilers will be similarly covered to a thickness of 1½ inches. The covering shall not be put on until the boilers have been subjected to the prescribed inspection test, and also tested under steam and found to be perfectly tight.

132. Inspection of boilers.—When completed in place and with all connections made, the boilers, together with steam and feed piping, will be tested by the Government inspector, and a certificate of inspection obtained, which will be filed with the engineer officer in charge before the dredge is accepted for the final test.

VALVES AND PIPING.

133. Pipe systems.—The pipe systems throughout the dredge must be complete in all respects, whether each part is specifically mentioned herein or not; they must be of suitable material, and have suitable fittings adapted to the several purposes for which they are intended; they must be well designed, with due regard to location, directness of connections, expansion, avoidance of water pockets and sharp turns liable to cause water hammer, and proper facilities for drainage, and must conform to the requirements of the Board of Supervising Inspectors of Steam Vessels. All piping throughout the dredge shall be strictly "full weight," and all piping used for hot water shall be of genuine wrought iron, not steel.

134. Valves, cocks, and fittings.—All valves 2 inches and under shall be made entirely of bronze, except where the nature of the service demands other material. All valves having iron bodies shall be fitted with bronze valves, seats, spindles, and glands; those for steam and feed, and as far as practicable all other valves shall have outside screws and yokes. All valves used for steam and feed or subjected to high pressures shall be "extra heavy" and of ample strength for the pressures they will carrry. All cocks used for vacuum and all cocks over 1 inch used for any other purpose shall have packed plugs. All valves shall be of high grade and approved by the engineer officer in charge. The ordinary commercial valve will not be accepted. Pipes and fittings over 2 inches in diameter used for steam, feed, or other high-pressure purposes must be connected by flange unions; all screwed unions throughout the dredge must be of bronze, of heavy pattern, and of first-class make; all screwed fittings must be of malleable iron, and those for high-pressure purposes must be extra heavy pattern.

135. Pipes discharging through hull.—All pipes discharging through the sides of hull will be connected by water-tight joints; all above 1¼ inches in diameter by flanges and bolts with cup heads on the outside, and the smaller pipes by lock nuts and washers. All pipes discharging under pressure will have elbows on the outside of hull. Where pipes pass through water-tight bulkheads the bulkheads must be fitted with collars and made perfectly water-tight.

136. Intake valves and pipes.—Intake pipes will be located in convenient and accessible places, carefully fitted to hull plates and securely bolted or riveted, and will have screen plates or bars at entrance. Each intake will have a gate valve as close to the hull as possible and a steam connection for clearing away drift.

137. Suction wells.—Each intake pipe will be connected to a suction well of suitable size for the purpose it is intended to serve. These wells will be made from ¼-inch steel plate and have substantial flanges with covers bolted on, also inlet and outlet branches of the number and size required, substantially riveted to the shells. Each well to have a brass-wire screen of suitable mesh and gauge of wire attached to a separate iron frame, which will slide in grooves provided for it on the sides of well. A wash and drain plug with short nipple will be fitted in the bottom of each well.

138. Steam-pipe lines.—All steam pipes 5 inches in diameter and over shall be of lap-welded standard pipe, connected by steel flanges, which shall be bored slightly taper outwardly, with ends of pipes expanded to a tight fit, beaded into a countersink on the face of the flange, and riveted through hub of flange, and face of flange and end of pipe turned off true after riveting. All steam pipes over 2 and under 5 inches in diameter shall be of lap-welded extra strong pipe, connected by steel flanges which may be screwed on. All pipes under 2 inches shall be standard pipe with screwed connections. All flanges of pipes and fittings shall be made with male and female rabbets. All fittings shall be of the extra heavy pattern, and all flanges, rabbets, bolt circles, and the number and size of bolts shall conform strictly to the accepted standard of dimensions.

139. Main steam line.—The main steam valves on each boiler shall be 7 inches in diameter, located as shown on drawing, the branches connecting to mains 9 inches in diameter which will run forward to the main pump engines, and then be reduced in proportion to the requirements. Branches shall be provided for all engines at convenient locations, and each branch shall have a shut-off valve close to the main, in addition to the one on the engine or machine which it supplies. Two balanced expansion joints and two steam separators shall be furnished with the main steam line.

140. Auxiliary steam line.—The auxiliary steam line shall be 4 inches in diameter and shall be connected to the refrigerating plant, electric-light engine, shop engine, feed pumps, bilge siphons, and such other small pumps and engines as may be most conveniently served from this line. Each branch shall have a shut-off valve close to the main pipe in addition to those on the engines. The auxiliary steam valves will be located on the steam drums as shown, and all valves and fittings will conform to the general conditions specified above.

141. Exhaust pipes.—The exhaust pipes from main, propelling, and jet-pump engines to the surface condenser, shall be of copper, No. 16 U. S. G. Bends shall be of as large radius as practicable, flanges shall be of cast iron, bored a snug fit for the outside of their respective pipes, and neatly rounded to fit the neck of copper flange; the ends of pipes shall have flanges formed of short sections of copper, and must not be less than ½ inch thick and 1 inch wide. All other engines and pumps shall exhaust into the feed-water heater, and connections shall be made with standard pipe and fittings. All exhaust pipes will be fitted with straightway valves, close to condenser or heater, so that any machine on the dredge may be shut down for overhauling without interfering with the remainder.

142. Air and circulating pump connections.—The circulating pump shall have an independent intake pipe, gate valve, and suction tank fitted with brass-wire screen. The delivery from condenser will pass below deck and through side of hull. The air pump will deliver into the end compartment of the feed-water filter tank and be provided with a connection to the atmosphere rising about 7 feet above the hurricane deck and terminating with a neat bell mouth.

143. Feed pipes.—The suctions of feed pumps will take from the hotwell, and will also have a direct connection with the river. The feed pumps will deliver into the feed-water heater, from which an independent line of pipe will run to each battery of boilers. The regulating valves for feed to boilers will be located conveniently for handling from the rear of boilers. All necessary valves for operating the pumps, either together or separately, must be supplied; also a spring-loaded relief valve, the discharge from which will be returned to the hotwell.

144. Fire-pipe line.—The fire main shall be 4 inches in diameter, to run fore and aft of the vessel with branches and risers at such places as are required for the convenient distribution of the fire plugs. There will be two fire-hose branches on each side of house on main deck; three branches on each side of cabins and two branches on each side on hurricane deck. The branches shall be 2 inches in diameter, fitted with brass-hose valves with caps on outlet, and a hose key for each valve secured in place by a brass chain. Hose couplings shall have standard pipe threads.

145. Pipes for pile sinking.—A connection shall be made from the fire line to convenient locations on the forward deck for supplying water for sinking the hydraulic piles. Nozzles for 2½-inch hose to stand above the deck and shut-off valves near the nozzles shall be provided in addition to the main shut off at pump.

146. Escape pipes.—The escape pipes from safety valves shall be joined together into one pipe, which will run up the after side of center chimney to the top and terminate with a neat band. These pipes will be 6 inches in diameter, made of galvanized sheet steel No. 16 U. S. G., with flange connections. The pipes must be closely riveted and galvanized after being riveted. The flange ends shall be of copper, bolted together by follower flanges of wrought iron. The escape pipe shall be properly secured by clip braces riveted to the chimneys.

147. Drain pipes.—All parts of the steam-pipe system, and other pipes and engines where water may accumulate, shall be amply provided with drain pipes which will discharge into a tank conveniently located in the hold from which the water will be pumped into the feed-water filter tank. All water pipes, pump chambers, etc., shall be fitted with drain valves, cocks, or brass plugs for draining them entirely of all water when required.

148. Pipe covering.—All live steam pipes and feed-delivery pipes throughout the dredge shall be covered with genuine magnesia nonconductor containing not less than 85 per cent of magnesia. The covering shall be of standard thickness, put on in the best possible manner with all ends and joints properly filled in and made airtight, covered with cotton duck and painted two coats of white paint. The covering shall not be put on until the pipes have been tested by the inspector, tried with steam at the full working pressure and all joints found perfectly tight.

DREDGING PLANT.

149. Main dredging pump.—This pump will be of the double-suction centrifugal type with 36-inch discharge and will be made in accordance with the detail drawing No. 8. The pump casing will be divided horizontally through the axis of the shaft and the top half will be again divided vertically. If the builder desires, in order to facilitate the machining of the inside surfaces, the casing may also be divided in the middle of the width as shown on the drawing. All joints must be truly machined and put together in a thoroughly first-class manner, dowel bolts being provided where necessary for keeping the sections perfectly fair with each other. The suction ports shall be bored to 45 inches in diameter and the flanges shall be faced and recessed ⅝ inch deep to receive the throat rings. The whole internal surface of the casing shall be fitted with liners; those for the sides to be of cast iron ¾ inch thick, made in two courses and in sections as shown on the drawing, and secured in place by 1-inch countersunk bolts. The shell liners shall be of steel plate, ½ inch thick, made in sections as shown, and secured by ⅞-inch countersunk bolts. The edge of discharge port shall be protected by a steel lip secured by four 1-inch countersunk bolts. The throat rings shall be in halves, with faced joints and shall be machined as required and made a snug fit in suction ports. The inside faces of casing will be machined for the wearing ring and the first course of liners. The side liners must be fitted closely against the shell liner on their outer edges, and all the liners must be fitted in close contact at their joints, and those edges which terminate at the partings of the pump casing must finish exactly flush with the faces of the joints of the casing. All liners when in place must present a fairly smooth and even surface; all adjacent parts must fit closely; all irregularities of joints must be dressed off, and all bolt heads must be exactly flush, neither full nor short of their respective countersinks. The wearing rings shall be made in four sections, fitted closely at the joints and around the throat rings, and each section shall be secured by three ⅞-inch countersunk bolts. They shall be cast on a chill and faces made as hard as practicable and all sections must be strictly interchangeable.

The pump runner will be of the inclosed type, 90 inches outside diameter, and of the dimensions given on the drawing. The spider will be a steel casting with three arms, on which will be cast blades curved and flanged as shown. Three independent blades, similarly shaped and flanged, will be set midway between the arms. All blades shall be machined to a width of 25 inches, with side plates attached by ⅞-inch rivets countersunk and flush on both sides. The wearing rings shall be duplicates of those on the pump casing as described above. Beyond the wearing rings the side plates will be protected by liners of 5/16-inch steel plate in six sections, secured by ⅝-inch rivets countersunk and flush on both sides. Both the inside and outside edges of side plates and liners, and the joints of liners, shall be machined; and the side plates shall be properly straightened before being riveted in place. If not true on face they shall be rough turned, but in no case shall their final thickness be less than 11/16 inch.

The suction elbows will be made in halves and set at the angles shown on the drawing; the flange for connecting them to casing being recessed ⅝ inch to fit snugly over the throat ring. The outer ends of elbows will be provided with stuffing boxes and glands for the suction pipe, and the shaft stuffing boxes will be fitted with cast-iron glands and bronze collar bushes, and bronze oil and water rings. All shaft fittings will be in halves, put together with faced joints. Each elbow will have a 12-inch hand-hole, located where shown, the covers to fill the holes closely and to be flush with the inside of pipe. The pump will be provided with two 4-inch air exhausters with flange connections; lifting plates and shackles, jackscrews for breaking joints, and all necessary steam and water valves, oil and grease cups, and pipe connections.

150. Pump shaft.—The pump shaft will be of open-hearth steel of the dimensions given on the drawing; the couplings will be forged on and the shaft will be enlarged in the middle to ⅛ inch in excess of the outside diameter of the couplings, to form the runner seat. The runner shall be a tight fit on the shaft and secured by two keys driven in opposite directions and finished with two false hubs or collars of cast iron fitting closely to the shaft and runner hubs and secured by tap bolts as shown. After the runner is keyed on and completely finished the shaft shall be hung in a lathe or on suitable bearings and tested for running true, and shall be balanced to the satisfaction of the engineer officer in charge. The pump shaft will be carried by two bearings independent of the stuffing boxes. These bearings will be of neat and suitable design, of ample strength, and will be carried from the tie frames which connect the pump and engines. These tie frames shall be of box form, with openings in sides or top to give access to the bolts in pump casing, and must be of ample strength for their intended service.

151. Extra parts for pump.—The following extra parts will be supplied with the pump, and each piece shall have been fitted in place, with all its fastening bolts. Such pieces as may require it shall be properly marked for easy identification. Two throat rings in halves, cast iron; one set of outer course liners, right hand, 11 pieces in all, cast iron; one set of outer course liners, left hand, 11 pieces in all, cast iron; two complete wearing rings for casing, 8 pieces; two complete wearing rings for runner, 8 pieces; two sets of $\frac{5}{16}$-inch steel wearing plates for runner, 12 pieces; one cast-steel lip for discharge port, with 4 bolts; one set of $\frac{1}{2}$-inch plate steel shell liners; one set of 1-inch countersunk bolts for liners, 102 in all; one set of $\frac{7}{8}$-inch countersunk bolts for wearing rings, 24 in all; one set of $\frac{7}{8}$-inch countersunk bolts for shell liners.

152. Main pump engines.—The pumping engines will be horizontal tandem compound condensing "Ideal" engines. The stroke will be 24 inches. The engines will be designed to run at a speed of 140 to 145 revolutions per minute, and will be required to develop 1,500 indicated horsepower at the latter speed. The steam pressure at boilers will be 150 pounds per square inch and the vacuum in condenser about 22 inches. The engines must be designed for heavy and continuous service and should not exceed in width the space allotted to them on the plan. The crank shafts will have a flange coupling on one end worked solid with the shaft. The bearings must be of ample proportions, and the engines thoroughly controlled by shaft governors. Metallic packing shall be used for piston and valve rods and all necessary automatic drain cocks, relief valves, sight feed and other lubricators, and indicator cocks and mechanism for taking diagrams will be furnished. A steam separator, with gauge glass and drain cock complete, a steam stop valve, and a balanced throttle valve will be provided for each engine, with a convenient means for handling the same. The cylinders will be covered with genuine 85 per cent magnesia nonconductor and lagged with No. 14 sheet steel.

153. Forgings.—All heavy forgings for engines, etc., throughout the dredge, such as crank and other shafts, connecting rods, crank and cross-head pins, etc., shall be made of open-hearth steel of medium-hard quality, and shall be thoroughly and carefully annealed after forging. They shall be finished all over, except where otherwise specified, and all bearings and working surfaces shall be finished and polished in the best possible manner. All small forgings of steel shall be properly annealed after forging, and the engineer officer in charge may at his discretion require any material or forged piece to be tested in order to satisfy himself of the strength or suitability of the said material or forged piece for the purpose for which it is intended. Such tests shall be made by and at the sole expense of the contractor.

154. Surface condenser.—The condenser shall be of ample capacity for the main pumping engines and the jet-pump engine when developing a total of about 1,800 indicated horsepower. The shell shall be of cast iron and either cylindrical or rectangular in form, as may best suit the conditions of floor space and height. The tube heads shall be of iron and the tubes seamless drawn brass tinned inside and outside, both ends plain, and secured by screwed glands with inside shoulders to prevent creeping of tubes. All parts of condenser shall be of very close-grained iron, smooth of surface, free from flaws and blowholes, and of adequate strength. The condenser will also be used for the propelling engines, but only occasionally at the same time as the pumping engines, and then only to the extent of about 100 indicated horsepower. As the temperature of the circulating water may be as high as 80° F. and the water will hold a considerable amount of mud in suspension, the circulating water should be more abundant and the tubes of larger diameter than usual.

155. Air pump.—The air pump shall be of the vertical simplex beam type, of Blake or Worthington manufacture or other of equally good design and workmanship, and of suitable size for the condenser. The pump cylinder shall be composition lined, fitted with composition bucket, bucket rod, and head valves and otherwise fitted and furnished according to the best marine practice.

156. Circulating pump.—The circulating pump shall be of the centrifugal type, direct connected to a vertical engine self-contained on one bedplate, and will be of substantial construction and furnished with all requisite automatic sight-feed lubricators, stop valve, drain cocks, etc.

157. Jet pump.—The jet pump for supplying water to the nozzles of the water-jet agitator will be a 20-inch centrifugal, direct connected to a vertical compound condensing engine, and mounted on a heavy subbase. The pump will be required to deliver about 8,000 gallons of water per minute at a pressure of 20 pounds per square inch. The engine shall be substantially built and have large wearing surfaces, adapted to continuous running, and shall be fitted up in the best possible manner, the reciprocating parts efficiently balanced, and all the usual and requisite stop valves, drain cocks, automatic sight-feed and other lubricators, etc., supplied and neatly mounted. Indicator cocks and mechanism for taking diagrams will be provided. Cylinders will be covered with genuine magnesia nonconductor and lagged with No. 14 sheet steel. This engine will exhaust into the condenser.

158. Suction pipes in hold.—The suction pipes for main pump will be 25$\frac{1}{2}$ inches inside diameter and neatly formed to the required shape to suit the elbows on the pump, as shown on the drawings. They will be made of 12.75-pound plate, the courses will be tapered, all seams lapped and single riveted with driven heads flush on the inside, and made absolutely air and water tight. The forward ends will be 25½ inches square and will have substantial cast-iron flanges riveted on to suit the inboard connection of radial joint. The after ends of pipes will terminate with cast-steel or lap-welded sections, machine finished on the outside to fit the stuffing boxes on ends of pump elbows. The curved parts of suction pipes will be made in as small sections as practicable in order to give a smooth and easy waterway. Such flange connections and bulkhead flanges as may be required for the proper handling of pipes and making of joints will be provided and fitted in a satisfactory manner.

159. Discharge of main pump.—The section of discharge pipe from pump to bulkhead 47 will be made as indicated on general drawing No. 1. The forward end will be 30 by 36 inches with a heavy cast-iron flange to suit the pump. The after end will terminate in a cast-steel or lap-welded section, machine finished on the outside to fit the stuffing box in bulkhead. The stuffing box will be machine finished in the packing chamber and gland, and connected to the bulkhead by bolts outside of the flange which secures the discharge pipe to the after side of the bulkhead. A manhole will be provided in the discharge pipe as near to the pump as possible, the cover to be flush with the pipe on the inside. The first length of pipe at pump may be of cast iron or of steel plate ⅜ inch thick; the change in shape must be gradual, and at least 4½ feet long. The body of pipe will be of 12.75-pound plate, and conform to the remainder of discharge pipe in hold, as specified in paragraph 70.

160. Discharge of jet pump.—This pipe will be made from 10.2-pound plate, and of such length and shape as is required by the location of the pump. The seams shall be single-riveted lap seams, with driven heads flush inside, in taper courses laid with the flow of water, and the pipe must be perfectly water-tight. The flanges shall be of cast iron of ample strength, and all faces shall be machine finished.

161. Radial joints.—Each radial joint will consist of five parts—the hinge frame, the gland, the radial arm, the telescope pipe, and the inboard connection. These joints will be made in accordance with the detail drawing No. 10, machined in all parts as indicated or required, and well and accurately fitted together in a first-class and thoroughly substantial manner. The several parts will be of cast steel or iron as called for by the drawing, and special care must be exercised to obtain thoroughly sound and perfect castings. All gland studs shall have brass nuts. The bolting to hull shall be done in a thoroughly workmanlike manner, and the joint packing shall be approved by the engineer officer in charge. When the hinge frames are in perfect alignment, four holes in each frame shall be reamed out and drive bolts put in to insure permanence of alignment.

162. Suction head.—The suction head will be constructed in accordance with drawing No. 9. Any needed detail drawing will be furnished to the contractor by the United States. The suction head is designed for dredging both up and down stream, and is provided with two sets of jet nozzles, to either of which water may be admitted at will by means of a valve in the center of the pressure chamber, operated from the deck by means of pitch-chain and wire-rope gearing. Four flap valves close the downstream entrance, and are so arranged that when opened for dredging downstream they will close the upstream entrance. These valves are operated in pairs by small hydraulic cylinders placed at the upper end of suction pipes and connected to the water supply by jointed pipes. The suction head will be 33 feet long from the center of hinge pin to the lip, with mouthpiece 32 feet wide over all. The mouthpiece will be built separately from the suction head and will be attached thereto by a bolted flange joint as shown. The two throat pieces will be shaped as shown, contracting toward the suction pipes, which will be 24 inches square inside, and will terminate in the steel radial arms by which the suction frame is suspended. The two suction pipes will be tied together by a system of lattice bracing as shown. All plates used in the construction of suction head shall be rerolled until perfectly straight, and all angle bars shall be properly straightened before being finally riveted in place. The bottom plate of mouthpiece will be ½ inch thick, 23¾ inches in finished width, and 32 feet long, machined to a bevel on the after edge to receive the flap valves when closed. On the underside of bottom plate will be riveted two 6 by 4 by ¾ inch angles, as shown, running the full length in one piece and slotted to receive the jet nozzles. The top plate of mouthpiece will be ½ inch thick, 22½ inches wide, and 32 feet long, and to its after edge will be riveted a ⅜-inch plate bent to the required angle and having a 4 by 4 by ¾ inch angle 32 feet long riveted to its after edge to connect to suction pipes. The top and bottom plates will be connected by flanged end pieces of cast steel and three intermediate separators of cast iron. All of these pieces shall be machined to 10 inches in depth, shall have bearings for the flap valves, fitted with steel caps, and shall be secured in place by rivets or through bolts as required. At the lower and after end of mouthpiece there will be a 6 by 4 by ¾ inch angle, riveted to the end flanges and secured to each separator. This angle forms the bottom flange of mouthpiece by which it is bolted to the suction pipes. The flap valves will be of steel plate ½ inch thick, riveted to steel back bars, as shown. A lever will be cast on each back bar for operating the valves. The journals and faces of back bars and edges of valve plates will be machined, and provision made in back bar for a gasket, as shown on the detail drawing. The top and bottom plates will be perforated to receive the 36 distributing pipes from the pressure chambers to the nozzles. These pipes will be 3 inches in diameter, extra strong, truly faced on each end, and will fit into recesses in the top plate and nozzles with suitable water-tight gaskets. The nozzles will be steel castings, secured by two ⅞-inch square-neck countersunk bolts to each, and by bolting together in pairs as shown. The upstream mouth will be screened by pipe ferrules and ⅞-inch bolts passing through the top and bottom plates and spaced, as shown on drawing. The ferrules shall be of 1-inch extra strong pipe. Shields for the distributing pipes, made from $\frac{3}{16}$-inch plate, will also be provided. Each shield will be in one piece, bent to the required shape, riveted together at the edges with flush rivets, and must be a snug fit between the plates of mouthpiece. The downstream mouth will be screened by steel bars of the form and dimensions given on the drawing, secured in place by ⅞-inch bolts. The nozzles will be protected by steel shoes fitting between and bolted to the bottom angle bars. The pressure chambers will be built on top of mouthpiece, as shown on the drawing. The plates will be $\frac{5}{16}$ inch thick, and angle bars ⅜ inch thick and of the different sizes called for. The chambers will be required to stand a working pressure of 20 pounds to the square inch, and will be tested for water-tightness before being accepted. The valve chamber will be a steel casting bored to a smooth surface and having flanges cast on the outside for riveting to the walls of pressure chamber. The valve will consist of a cast-iron bull ring, fitted with bronze packing rings, and will be actuated by two racks and pinions on the inside of jet pipe. There will be a cover at the forward end of valve chamber to give access to the valve without removing any of the pipe connections. At the after end of valve chamber there will be a cast-iron junction pipe 23 inches long, tapering from 20 inches to 17 inches diameter, and provided with stuffing boxes to receive the actuating spindle. The lifting lugs for the hoisting tackle will consist of plates ¾ inch thick, shaped as shown on drawings and riveted to the pressure chambers with double angle clips. The suction head will be built in a thoroughly first-class and workmanlike manner. Parts will be machined where noted or where required to insure good work, outside rivet heads will be neatly cupped, inside rivets driven flush, and pipes calked and made air-tight.

163. *Jet pipe.*—The jet pipe will be 20 inches in diameter and curved at the lower end to connect with junction pipe on suction head. The upper end will be 18 inches square to suit the radial pipe. The pipe will be made from ¼-inch steel plate with single riveted laps, riveted flush inside, and made water-tight under a working pressure of 20 pounds per square inch.

164. *Safety chains for suction head.*—Chains or other suitable means of securing the suction head when not in use will be provided.

165. *Hoisting frame and pile derricks.*—The hoisting frame and pile sheers for handling the suction head and the hydraulic piles will be built as shown on drawing No. 11. The A-frame legs will consist of 12-inch by 20.5-pound channels, latticed together and fitted with cheek plates for pin connections at the lower end. They will be riveted together at the upper end with ½-inch plates, and held in position by a stiff back leg consisting of two 8-inch by 11.25-pound channels tied together and pin connected to A frame and deck. The sheer legs for hydraulic piles will consist of 8-inch by 11.25-pound channels latticed together and fitted with cheek plates at the lower ends for pin connections to deck. The upper ends will be riveted together with ½-inch plates and provision made for hoisting tackles and back braces. These back braces will consist of two 6-inch by 8-pound channels tied together and pin connected to the head of A frame. The sheer legs will be stiffened by cross ties of 3-inch extra strong pipe, pin connected as shown on the drawing. All parts of the hoisting frame and derricks must be neatly made, riveted with snap heads on the outside, have all projecting edges dressed off flush, and all sharp corners and rough edges removed.

166. *Hoisting tackle.*—The hoisting tackle for suction head will be suspended from the A frame and will consist of wire-rope sheave blocks for five parts of ⅜-inch diameter rope. The sheaves shall be not less than 30 inches in diameter at the bottom of groove, grooves finished, eyes bushed with bronze, pins 4 inches diameter, with provision for lubricating with grease. The connection to suction head will be a two-leg sling chain 1⅜ inches in diameter, of best quality and make of dredge c[illegible]n, proof tested. The coupling links shall be made as shown, and held in position

by a distance bar of 4-inch extra strong pipe secured by a 1½-inch through bolt on which will be shrunk four collars, whose outside diameter will fit the inside of pipe. Special care must be taken to obtain perfectly sound forgings of suitable material, eyes in links must be bored, and connecting pins machined where cold rolled steel is not used.

167. Hoisting rope.—The hoisting rope will be of best quality ¾-inch flexible wire rope, with a guaranteed breaking strength of not less than 56,000 pounds.

168. Hoisting winch.—This winch will be made substantially as shown on drawing No. 13, but latitude will be allowed the contractor for the use of existing patterns, provided the conditions of space and power are maintained. The engines will be horizontal, with cylinders 7 inches in diameter and 7-inch stroke, covered and lagged with sheet steel, and shall be fitted with link-motion reversing gear. The winch will be geared about 32 to 1, the pinions to be of cast steel and the wheels of gun iron of not less than 28,000 pounds tensile strength, and the framing well proportioned and of extra strength. The winch will be fitted with brake, reversing and brake levers, and all necessary lubricators, valves, drain cocks, etc. The character of material and workmanship and the general finishing and fitting of this winch shall conform to the standard of the main engines.

169. Bow hauling winches.—Two winches for handling the head cables will be located on the forward deck as shown. These winches will be made substantially as shown on drawing No. 12, but latitude will be allowed the contractor for the use of existing patterns, provided all conditions of space, power, and variations of speed are maintained. The engines will have cylinders 7 inches in diameter and 7-inch stroke, fitted with either steam or link motion reversing gear. The first motion will be worm gearing, the remainder spur gearing, in such ratio that the cable may be hauled in at speeds varying from 15 inches to 35 feet per minute, with engine speeds varying from 50 to 250 revolutions per minute. The worm will be of bronze, the pinions of cast steel, the spur wheels of gun iron of not less than 28,000 pounds tensile strength, and the clutches of cast steel. All gears running loose will be bushed with bronze. The drum will be loose on shaft and driven by a friction band to admit of slipping under extraordinary strains. The winches will be fitted with brakes of ample power and will have gypsy heads on the outer ends of worm shafts. All clutch levers, lubricators, valves, drain cocks, and other fittings that are necessary for the complete outfitting of the winches must be supplied. Test pieces of the metal from which the wheels are cast will be required, and such tests for tensile strength as the engineer officer in charge may deem necessary shall be made by the contractor without cost to the United States. The character of material and workmanship and the general finishing and fitting of these winches shall conform to the standard of the main engines.

170. Cables.—Two best quality crucible-steel wire-rope hauling cables will be supplied, 1 inch in diameter and 1,600 feet long each, with a guaranteed breaking strength of 66,000 pounds. An eye will be spliced on one end of each cable, the other ends being secured to the drums of the hauling winches.

171. Spud anchor and steam lift.—The spud anchor will be of Oregon fir of the quality known as ship timber, or of upland white oak. It will be 26 inches square and 36 feet long, and must be free from all imperfections, and must not have more than 2 inches of wane on any of the corners. The spud will be fitted with a cast-iron point, secured by drift bolts passing through four ⅜-inch steel plates riveted to the point. Eight pieces of steel rack, in 3-foot lengths, will be fitted into one face of the spud and secured by ⅞-inch through bolts, the bolt lugs being so spaced that the pieces shall be interchangeable. The steam lift will be made in accordance with drawing No. 14. The cylinder will be 20 inches in diameter with a stroke of 6 feet, with piston having three metallic packing rings, 4-inch steel piston rod, and top and bottom covers. The lifting cam will be a steel casting, the side links will be forged steel, with the eyes bored, and all pins will be of steel. The back plate will be 1 inch thick and 10 inches wide, and back bar and plate will be secured by strap bolts to the oak gripping block. The tripping dog will be forged steel, and will be fitted up in the best possible manner to take a bearing on the outside of knuckle. The dog will be hinged in lugs cast on the deck flange and will be provided with a suitable tripping lever. Stoppers of white oak will be secured to the deck flange as shown to stop the cam and gripping block when down. A steam operating valve and all requisite pipe connections, drains, and lubricators will be furnished, the pipes being connected with flexible couplings of approved make where required to provide for the movement of the cylinder. The base plate for supporting the cylinder will be a steel casting secured to the keelson and bulkhead as shown on the drawings.

172.—Capstans. Four steam power single barrel capstans are required; two for the forward deck and two for the stern, located as shown on the general plan. These capstans will be "Hyde" or "Providence," or others of equal quality, approved by the engineer officer in charge. The engines will have cylinders 7 inches in diameter and 8-inch stroke, and will be fitted with reversing gear. The cylinders shall be lagged and all operating valves and levers, drain cocks, lubricators, etc., shall be supplied and mounted in a satisfactory manner.

PROPELLING MACHINERY.

173. Engines.—Each paddle wheel will be driven by a horizontal cross-compound condensing engine, exhausting into the same condenser as the main engines. They will be located on the main deck as shown on the general plan, and coupled to the paddle wheel by means of spur gearing. The stroke will be 30 inches, and each engine will be required to develop 500 indicated horsepower when running at a maximum speed of 100 revolutions per minute with a boiler pressure of 150 pounds per square inch and a condenser vacuum of about 22 inches. The engines will be fitted with link-motion valve gear, and will be operated separately, by suitable throttle and reversing levers, conveniently located for handling by one man. The engines must be designed for heavy and continuous service, must be carefully counterbalanced, and all moving parts must be fitted with means for taking up the wear. The crank shafts may be either forged solid or built up, and the shaft bearings must be of ample proportions to insure cool running under the severest conditions. The piston and valve rods will be fitted with metallic packing, the cylinders covered with genuine magnesia nonconductor and lagged with No. 14 sheet steel, and all necessary sight feed and other lubricators, relief valves, drain cocks, indicator cocks, and mechanism for taking diagrams furnished and mounted in a satisfactory manner. Each engine will be furnished with a steam separator fitted with gauge glass and drain cock, and with a shut-down valve in addition to the throttle valve, which will be of the balanced type.

174. Gear wheels.—These gears will be of 5-inch pitch and 13 inches face, the wheels having 106 teeth and the pinions 21 teeth. The wheels will be made in halves, proportioned to withstand possible shocks from drift and snags, put together with machined joints and strongly bolted. The wheels must be machine molded and perfectly true both in diameter and pitch, and must be cast from gun iron of not less than 28,000 pounds tensile strength. Coupons for tests must be cast with each gear, and such tests for tensile strength as the engineer officer in charge may deem necessary shall be made by the contractor without cost to the United States. All gears shall be a pressed fit on their respective shafts.

175. Paddle shafts and flanges.—These shafts shall be of open-hearth steel, subject to the general conditions stated in paragraph 153. They will be of the sizes given on drawing No. 4, machined where noted and smooth forged in the hexagonal body. Each shaft will be fitted with three cast-steel flanges 7 feet in diameter firmly keyed in place. The flanges will be provided with pockets for 20 wheel arms, of the dimensions given.

176. Shaft bearings.—Inboard and outboard bearings shall have large wearing surfaces, the pillow blocks to be heavy and fitted up in a first-class manner to take up wear, the faces properly machined, and all securely bolted and keyed to the sole plates on bridgetrees. Provision will be made for lubrication with both oil and grease.

177. Paddle wheels.—The wheels will be 28 feet in diameter over the buckets, with three sets of arms, 20 arms to each set, and will be built in accordance with best river practice. The buckets will be 14 feet long, 30 inches wide, and 1⅝ inches thick; the arms will be 12 inches wide from the outer end to the circle, tapering to the flange, where they will be 8 inches wide, and then tapering to 2½ inches at the point, the thickness being 3¼ inches. The circle will be 22 feet outside diameter, the segments 7 inches wide, and 3¼ inches thick, set up with keys in the usual manner, secured by iron circles on each side 5 inches wide and $\frac{5}{16}$ inch thick bolted with one ⅝-inch bolt through each arm and three ⅝-inch bolts through each segment and made in sections of convenient length with the ends overlapped and an extra bolt in each lap. Three sets of braces will be fitted to the arms between the circles and flanges, held in place by ¼-inch boat spikes. Battens for buckets shall be 7 inches wide and 1⅝ inches thick, the buckets being secured by three ¾-inch stirrup bolts to each arm. All the timber for wheels to be of seasoned white oak, except the braces which will be of poplar and shall be dressed on two sides to the sizes given.

178. Gauges, etc.—The following gauges will be required and must be set up in convenient places as directed, mounted and secured in a suitable manner, and provided with drain cocks, stopcocks, and siphons. All exposed connecting pipes and siphons will be of brass with polished brass fittings:

Three 8½-inch dial pressure gauges, brass case, for boilers.

One 10-inch dial pressure gauge, nickel-plated case, for main steam; in engine room.

One 10-inch dial combination pressure gauge, nickel-plated case, for main pump; in engine room, to record pressure and head of water in feet.

One 10-inch dial vacuum gauge, nickel-plated case, for main pump suction; in engine room.

One 10-inch dial vacuum gauge, nickel-plated case, for surface condenser; in engine room.

One 10-inch dial eight-day marine clock, nickel-plated case; in engine room.

One 8½-inch dial pressure gauge, brass case, for main pump; on operator's platform.

Two 8½-inch dial vacuum gauges, brass case, for suctions of main pump; on operator's platform.

One 6¾-inch dial pressure gauge, brass case, for jet pump; in engine room.

One 6¾-inch dial pressure gauge, brass case, for fire pump; in engine room.

One 6¾-inch dial pressure gauge, brass case, for steam-heating system; in engine room.

One 6-inch dial pressure gauge, nickel-plated case, for steam-heating system; in cabin.

Besides the above, other gauges for special machines, such as ammonia compressor, water filter, etc., must be supplied as required.

179. Steam whistle.—The whistle shall be 8 inches in diameter, with long bell, located between two chimneys and secured to the cross-tie. It shall take steam from the main steam line and have shut-off valve in addition to the whistle valve, pipe to be efficiently drained and whistle properly wired to pilot house.

180. Ship's bell.—A ship's bell not less than 24 inches in diameter, mounted on frame, shall be located as directed and furnished with bell cords and fair leads to pilot house and main deck.

181. Bells and speaking tubes.—A complete outfit of signal bells and gongs from the pilot house to the engine room, from the engine room to the boiler room and return, and from the deck abaft the machine shop to the engine room, shall be furnished. The pilot's bells and gongs for the propelling engines shall have different tones from other bells and gongs. All bells shall be wired in a substantial manner, with hard drawn copper wire No. 10 B. W. G., the turns in wiring being made with sheaves and pitch chain, and additional spiral springs of hard brass being placed where necessary for pullbacks. Gong and bell pulls shall be of brass of large size and approved pattern, and suitable stanchions or other fixtures shall be provided for mounting them. A complete set of speaking and bell tubes shall be furnished, the tubes to be of tin 1¼ inches in diameter with trumpet ends and nickel-plated mouthpieces.

PUMPS AND TANKS.

182. Feed pumps.—There will be three vertical duplex steam pumps "Admiralty" pattern, with 7½-inch steam cylinders, 5-inch water cylinders, and 8-inch stroke. The water ends will be of hard, close-grained cast iron, lined with composition, the pistons of composition with fibrous packing, the piston rods, valve seats, bolts and springs of composition, and valves of composition or rubber suitable for the warm water from hot well.

183. Feed water tank and filter.—This tank will be 10 feet long, 36 inches wide, and 36 inches deep, made of steel plate, $\frac{3}{16}$ inch thick, and stiffened around the top edge with a 2 by 2 by $\frac{5}{16}$ inch angle bar flange to which will be secured a wood cover strongly made, and bolted to make a vapor-tight joint. The tank will be fitted with four screens of brass wire and burlap, held in place by guide bars of 1-inch angles riveted to the sides of tank, and with glass water gauge, wash-out and drain cock, overflow, etc. The overflow will have an open end, discharging into a funnel so that water flowing in this direction can be seen. The outlet will have an internal nozzle standing above the bottom of tank and covered by a stand pipe 8 inches in diameter and reaching to the top of tank, notches being cut at the lower end to admit water to the outlet. This tank will discharge by gravity into the hot well.

184. Hotwell tank.—This tank will be located in the hold near the feed pumps. It will be about 8 feet long, 30 inches wide, and 24 inches deep, the exact dimensions being dependent on its location, made of steel plate $\frac{3}{16}$ inch thick and stiffened around the top edge with a 2 by 2 by $\frac{5}{16}$ inch angle-bar flange, a section of the cover to be bolted on, to give access to the tank for cleaning out. The tank shall be fitted with a vapor pipe discharging through side of hull, drain cock and pipe, and a water-level indicator with stand and index in the engine room. This tank will receive water from the feed-water filter tank and from the clear-water storage tank, and all necessary connections and valves will be supplied.

185. Grease extractors.—Three grease extractors of approved make, of ample capacity to filter all the feed water used by boilers, will be supplied and connected directly to the feed pumps. These extractors will have by-pass arrangement of valves and pipes, and be furnished with spare sets of cartridges.

186. Feed-water heater.—This heater will be of the tubular type and of sufficient capacity to raise the temperature of the feed water to 180° F. The exhaust from all the auxiliary engines and pumps, except the four capstans and the machine-shop engine, will be discharged into the heater and a direct connection from the auxiliary steam line will also be made. The surplus steam and drainage will be taken into the condenser by means of an escape valve loaded to 3 pounds per square inch above the vacuum in condenser. The heater will be furnished with all necessary connecting pipes and valves, scum and drain cocks, etc.

187. Filter.—A pressure filter capable of filtering 600 gallons of Mississippi River water per hour will be furnished for supplying clear water for domestic purposes, and to replace the waste caused by leakage, blowing off, overflows, etc. A feed pump of suitable size for filter and all the necessary fittings and accessories for its satisfactory operation will be supplied.

188. Clear-water storage tank.—A cylindrical tank of 600 gallons capacity will be located in the hold. It will be made of steel plate $\frac{3}{16}$ inch in thickness, carried at the required height by substantial cradles and fitted with all necessary filling and outlet pipes and valves, man way, drain, etc., and shall be cemented on the inside.

189. Domestic water supply.—Hot and cold water tanks of about 100 gallons capacity each shall be placed on the hurricane deck and a complete system of galvanized-iron service pipes to all baths, wash basins, etc., shall be fitted as required. A duplex steam pump with 3-inch steam cylinders, 2-inch water cylinders, and 3 or 4 inch stroke, will pump water from the storage tank to the cold-water tank, and the hot-water tank will be supplied by means of a ball cock from the cold-water tank. The overflow pipe shall be returned to the storage tank in such a manner that the discharge can be seen. A small steam coil shall be furnished in hot-water tank.

190. Drainage tank and pump.—A closed tank of the same size and construction as the hot well will be placed in the hold to receive the drainage from all sources. This tank will have vapor pipe discharging through the side of hull, drain plug and connection to pump as required. A duplex steam pump with 4½-inch steam cylinders, 2¾-inch water cylinders and 4-inch stroke, and fitted for pumping hot water, will be required to pump water from this tank. A water-level indicator, with stand and index in engine room, will be provided.

191. Fire pump.—A horizontal duplex steam pump with 10-inch steam cylinders, 6-inch water cylinders, and 10-inch stroke, will be supplied for fire purposes. This pump will be fitted with brass plungers, inside packed, and full complement of valves and connections for fire line, branch for sinking the hydraulic piles, hose branch for washing decks, etc.

192. Deck pump.—A horizontal duplex steam pump with 5¼-inch steam cylinders, 3½-inch water cylinders, and 5-inch stroke will be located on the after deck as directed. This pump will draw direct from the river and will be used for fire-room purposes, supplying flushing tanks, washing decks, testing boilers, etc.

193. Pump fittings.—All pumps above specified must be of a make approved by the engineer officer in charge, and will be fitted with brass linings, pistons, and rods for the water cylinders; the steam cylinders will be covered with nonconductor and lagged with sheet steel, and all requisite lubricators and drain cocks will be supplied. All pumps will be set upon iron stands at a convenient height from the deck and have cast-iron pans, with drain pipes, to carry off all drips. The sizes of pumps as herein given may be varied to suit the particular sizes made by manufacturers, provided the capacity is not less than specified.

ELECTRIC-LIGHT PLANT.

194. The electric-light plant.—This will consist of a direct-connected engine and dynamo, 2 18-inch searchlight projectors, 2 32-candlepower incandescent signal lights, and 150 16-candlepower incandescent lights for general lighting; switchboard and fittings, switches, leads and wiring, fuse plugs, cut-outs, and other appliances necessary for a complete plant of the most approved type; all to be installed to the satisfaction of the engineer officer in charge.

195. Engine.—The engine will be a horizontal "Ideal" engine, self-oiling, automatically governed, and mounted on a subbase with the dynamo. The engine must be able to control a change from no load to full load, and must be of sufficient power to drive the dynamo at 350 revolutions, with an initial steam pressure of 90 pounds per square inch and a back pressure of 5 pounds above the atmosphere.

The engine will be furnished with reducing valve, steam stop valve, lubricators, drain cocks, etc., complete. The engine will be balanced for steady running, and the foundations so braced that no vibrations will be transmitted to the vessel.

196. Dynamo.—The dynamo will be a direct-current, compound-wound, multipolar, 15-kilowatt machine, giving a constant E. M. F. of 110 volts at terminals at 350 revolutions per minute, with a variation of not more than 2 volts in changing from maximum load to no load, with the field rheostat constant and the brushes at the neutral point. The armature will be thoroughly ventilated, well balanced, and firmly secured to shaft in such a manner as to admit of easy removal when required. The commutator segments shall be of hard copper 1½ inches deep, well insulated with mica, and of ample brush surface. The brushes shall be of carbon, and two complete extra sets shall be furnished. The brush holders shall be so mounted that they can be readily shifted simultaneously. There must not be any sparking at the brushes at full load nor any injurious sparking at half load, nor any undue heating of any of the parts when running at full load. The winding of both field and armature must be protected from mechanical injury and thoroughly waterproofed. No insulating material that can be injured by moisture or by a temperature of 200° F. shall be used. The field rheostat must have sufficient range to compensate for the increased resistance of the field coils due to heating.

197. Switchboard.—The switchboard will be of slate 1¼ inches thick, enameled all over, and of suitable size, and mounted with the following instruments: One round-pattern Weston voltmeter, reading to 150 volts; 1 round-pattern Weston ammeter, reading to 150 amperes; 1 shunt rheostat to regulate voltage from 10 volts below to 10 volts above normal; 1 two-light ground detector; 1 two-point voltmeter switch; 1 two-point ammeter switch; 3 double-pole knife switches of requisite amperage for the circuits; 2 110-volt pilot lamps on goose-neck brackets.

198. Wiring.—The two-wire system will be used, all conductors to be of soft-annealed copper wire of 96 per cent conductivity, and of sectional area properly proportioned to the current to be carried. The loss on any circuit from dynamo to lamp outlet at the farthest point on the circuit must not exceed 3 per cent when plant is running with maximum load. Wires in the cabins and on the main deck where it may be considered desirable will be run in moldings of clear, well-seasoned white pine, which shall receive a coat of white lead before being put up. When wires are led over steel beams, bulkheads, or decks, a wood backing, secured by brass machine screws, shall be put up and the molding fastened thereto. All wires passing through bulkheads shall be protected by porcelain tubes, and those passing through water-tight bulkheads in hold shall be led through water-tight metal stuffing tubes lined with rubber. All joints shall be made in a substantial manner, carefully soldered, and so taped and compounded that their insulation shall be superior to that of the wire. Joints shall be avoided in the main leads, and as far as possible throughout all the wiring. Junction or branch blocks shall be used and made water-tight where necessary.

199. Circuits.—There shall be three separate circuits, one for the projectors, one for the main deck and hold, and one for all cabins on the boiler deck, the pilot house, and signal lights. Suitable resistance coil on noncombustible frame will be supplied and placed where convenient as a dead resistance for projector main.

200. Junction boxes, switches, etc.—All junction boxes, switches, and receptacles must be separated from metal surfaces by a three-fourths inch thickness of hard wood, secured by brass screws. All fuses and switches will be mounted on incombustible bases of best insulating material. Except for a single lamp circuit, safety fuses of the water-tight type shall be provided for all switches and at the beginning of all branches which are of smaller size than the leads from which they are taken. Each fuse must carry the current for which it is used, and open the circuit when the normal current is exceeded by 33 per cent. Twice the number of fuses installed shall be supplied as extras.

201. Searchlights.—There will be two searchlight projectors of not less than 20 amperes capacity, mounted on suitable stands, one located at each end of the vessel in the position shown on general drawing No. 1. The projectors will have japanned brass cases with copper trimmings and "Mangin" mirrors 18 inches in diameter. The forward light will be controlled and operated from both the pilot house and the operator's platform at the bow of dredge, and the after light will be controlled and operated from the main deck. The wire rope for operating the lights will be galvanized and provided with means for taking up slack, all sheaves to be of large diameter and finished in the grooves.

202. Incandescent lamps.—The lamps shall be 110 volt, of 3½ to 4 watts efficiency, of standard pattern, with Edison sockets. They must be of the best quality and finish, uniform in size for the same candlepower, with metal anchors, and anchors and leading-in wires fused in glass. The base connection to bulbs must be water-tight, and the material used must be so treated as to insure against short-circuiting the lamp if exposed to moisture. The filaments must not droop when the lamps are set horizontally. Each lamp must be marked with the date of manufacture, the name of the maker, the rated candlepower, and the requisite voltage. There will be two 32-candlepower lamps for signal lights suitably mounted in colored globes and provided with proper wiring, cut-outs, and halyards for their safe and convenient use. There will be one hundred and fifty 16-candlepower lamps placed in clusters or singly at such points as may be directed, and furnished with keys, globes, shades, and guards suitable for their location and the purpose for which they will be used, including desk lights, portables, and electroliers. All outside lamps will be fitted with water-tight globes. All arrangements, fixtures, and attachments must be substantial, neat, and appropriate; all desk lights, lanterns, and portables must be wired with marine cord wire of such length as may be required. All lamps that can be reached from deck must have key sockets, but all others will have switches located at convenient places for handling.

203. Installation.—The installation and finish will be first class throughout and all details necessary for a complete and satisfactory plant are intended to be included in the foregoing specifications whether specifically mentioned or not; and the whole shall be in accordance with the established rules for the use and application of electric plants on board ships. The plant will be subject to inspection and test by an expert electrician in all its several parts before the dredge will be accepted; the expense of such test to be borne by the contractor.

REFRIGERATING PLANT.

204. The refrigerating plant will be of sufficient capacity to cool a storage room of about 500 cubic feet, and make about 800 pounds of ice per twenty-four hours when running sixteen hours with intervals of eight hours between runs. The plant will be of the ammonia compression system, adapted in all respects for use on steamboats and able to maintain a temperature of 34° F. in the storage room with an outside temperature of 100° F. The plant must be carefully built in accordance with the best modern practice, complete in every detail, and must not exceed the space allotted. Specifications and general drawings of the plant must be submitted with proposals as required by paragraph 38.

205. Cold-storage room.—This room will be located as shown on drawing No. 2 and built of such material and in such a manner as to obtain the best insulation practicable. It will be lined on the bottom and for 18 inches up the sides with No. 20 U. S. G. galvanized sheet steel, and have a false floor of slats made in sections for easy removal. The room will be fitted with drip troughs, drainpipe properly sealed, and shelves, racks, and hooks. The door will be fitted with large galvanized-iron or brass hinges, clamp, strap, and padlock complete.

206. Engine and compressor.—The engine will be horizontal, with cylinder about 8 inches in diameter by 7-inch stroke, mounted on a heavy base plate with the compressors. The cylinder shall be of hard, close-grained iron, and have balanced valve and be neatly lagged with sheet steel. The compressor shall have two single acting cylinders about 5½ inches in diameter by 7-inch stroke, made of semisteel accurately bored and ammonia-tight. Cylinder heads shall be of semisteel with valves of forged steel. Piston rods, connecting rods, and crank shaft shall be of forged steel throughout; crossheads of cast steel with bronze shoes; and all bearings of bronze or genuine babbitt. The machine shall have a heavy fly wheel to insure steady running, and be fitted with all necessary steam valves, drain cocks properly piped, lubricators, etc. The compressor shall be fitted with by-pass pipes to permit of pumping out the system.

207. Oil trap.—This will be of lap-welded tube with welded ends and furnished with gauge glass having automatic self-closing valves.

208. Ammonia condenser.—This will be of the double-coil system, the condensing water circulating between the inside and outside pipes. It will be located inside the wheelhouse or in some other convenient place outside the engine room.

209. Ammonia receiver.—This will be of lap-welded tube with ends welded in, and fitted with steel inlet and outlet valves, and gauge glass with self-closing valves.

210. Freezing tank.—This will be of a suitable size to contain eighteen 100-pound ice cans. It will be made of steel plate one-fourth inch thick, stiffened by 2½-inch angle bars and braced with stay rods. The coils will be of 1-inch extra strong pipe, fitted with all binders, distance pieces, headers, etc. The tank will be thoroughly insulated, and fitted with top frame and can covers of hard wood.

211. Ammonia pipes.—The ammonia pipes will be extra strong, with fittings of forged or cast steel of approved pattern. All pipes and fittings will be tested to 300 pounds per square inch air pressure at the manufacturer's works, and after being assembled on board the dredge they will be again subjected to an air pressure of 300 pounds and must be made absolutely tight under that pressure.

212. Brine coils.—The brine coils for cold-storage room will be made from 1¼-inch pipe, and of the dimensions required for their several locations; each coil will be bent from one continuous piece of welded pipe. All necessary hangers, valves, and and fittings shall be supplied, and all exposed brine pipes shall be covered with proper waterproof insulating material.

213. Filter.—A charcoal filter will be required, located on the top of the cold-storage room, at a proper elevation for filling the ice cans by gravity.

214. Pumps.—One circulating pump of ample capacity for supplying the condensing water for the ammonia coils, and one brine pump will be required. The latter pump will have the water end entirely of bronze, and both pumps will stand in cast-iron pans, with drains properly piped, and be furnished with necessary lubricators, etc.

215. Outfit.—The outfit for the refrigerating plant shall include the following fittings and accessories: One ammonia high-pressure gauge; 1 ammonia low-pressure gauge (mounted together on a cast-iron frame); 2 brine thermometers; 1 salinometer; 1 extra induction and 1 extra exhaust valve for compressor; 18 galvanized 100-pound ice cans, made of No. 18 galvanized steel, thoroughly riveted and soldered, tops reenforced by heavy steel band; 1 automatic can filler; 1 set of wrenches for all nuts; and lifting screws and other special tools required; 1 ammonia storage cylinder with 50 pounds of liquid ammonia.

216. Supplies.—The contractor will furnish all ammonia, salt, and other material for charging the machine and putting it in working condition, and also for operating it during the period of test, until the plant has been accepted by the engineer officer in charge.

217. Test of plant.—Before being accepted, the plant will be operated by the contractor for three days, running sixteen hours during the day and shutting down eight hours at night, during which time the plant shall produce 800 pounds of ice per twenty-four hours, and maintain a temperature of 34° to 36° F. in the cold-storage room.

PONTON PIPE LINE.

218. Pontons.—There will be 10 pontons, 28 feet in diameter, 5 feet 3 inches deep at the center, and 2 feet 3 inches deep at the edges, built and fitted according to drawing No. 15. A semicircular trough of 19½ inches radius for the discharge pipe shall run fore and aft of deck, with doubling plates and bearing bands riveted at each end. The decks of pontons will be cambered 3 inches from center to rim; the bottoms will be frustums of cones, 6 feet in diameter at small end, and with a vertical height of 2 feet 9 inches. The floors and deck beams will be 3 by 2½ by ¼ inch angles running athwartship, tied together by stanchions of 2½ by 2½ by $\frac{5}{16}$ inch angle bars. In the center will be a transverse truss, as shown on the drawing. Gunwales and knuckles will be of 2½ by 2½ by $\frac{5}{16}$ inch angles, and the sides will be stiffened by 3 by 2½ by ¼ inch angles. Nosings of white oak 1½ by 6 inches will be bolted on the sides of pontons as shown. These nosings will be in one piece in length, and have a layer of heavy sheathing felt laid underneath them. Each ponton will have a manway with cover, in which will be inserted a 1½-inch brass plug for passing the hose for pumping out, four cast-iron cavels, and two cast-steel bits or two adjusters for check ropes. These deck fittings will have reenforcing plates riveted to deck as shown.

219. Pipe line.—The pipe line will consist of 5 sections of pipe each 100 feet long, and one junction pipe 8 feet 4 inches long. These pipes will be 36 inches in diameter, of steel plate $\frac{5}{16}$-inch thick, built with taper courses laid in the direction of the flow of water, the longitudinal seams to be opposite to each other in alternate courses. The four center laps and the end laps will be double riveted, the remainder will be single riveted. At one end of each pipe there will be a bell made from ⅜-inch plate, riveted into the end of steel socket; at the other end will be a short piece of pipe butt jointed, on which will be riveted the cast-iron ball as shown on drawing No. 15, the butt joint being made by patch bolts on a bar provided for that purpose in the ball. These butt joints must be close fitting and water-tight. The last length of pipe will have the baffle plate attached instead of the ball. Each length of pipe will have four bands 2½ by ½-inch riveted on, in the proper position to fit on the inside of bearing bands on the pontons, in order to prevent any lateral movement. The bearing bands and bands on pipes must be accurately set to templets so that pipes may be interchangeable. The pipes will be secured to the pontons by strap-bolts.

220. *Ball and socket joints.*—The flexible connection between the pipes will be obtained by balls and sockets as shown on the drawing. The balls will be of cast iron 5 feet in diameter and 46 inches in length, riveted to the pipe at each end and along the butt. The balls will be finished on the outside and also in the bore unless accurately and smoothly cast to the required dimensions. The sockets will be steel castings with the loose or gland half in two pieces put together with faced joints. The two halves of sockets will be bolted together with swing bolts as shown, the bolts to be accurately spaced in order to permit the gland to be turned to any required position. The joints will be faced and bearings of sockets accurately finished to a snug fit for the balls. The sockets will be made water-tight by gaskets, chambers being provided for this purpose.

221. *Baffle plate.*—The last section of pipe line will be provided with a baffle plate 66 inches in diameter, made of ¼-inch plate, strengthened with a 2½ by 2½ by ¼-inch angle around the edge. This plate will be carried by four cast-steel arms which will be bolted to the end of the pipe. A deflecting plate will be pivoted vertically between two arms, and will be controlled by a lever and quadrant as shown on drawing No. 15.

222. *Run ways.*—Each length of pipe will have running boards mounted on the top side between the pontons. These boards will be spiked to wood saddles, the end ones being made of sufficient length to be secured by strap bolts passing around the pipe.

223. *Junction pipe.*—This pipe forms the connection between the dredge and the pipe line, and will be 8 feet 4 inches long between centers of ball and socket joints. These joints will be similar in all respects to those on the pipe line. A lifting band will be clamped on the body of this pipe as shown on drawing No. 15, with side lugs forged on for check chains. All necessary chains, shackles, and other fastenings will be supplied.

224. *Check ropes.*—The first ponton from dredge and each pair of pontons at flexible joints will be provided with check ropes to limit the amount of deflection. These ropes will be 1 inch in diameter crucible cast-steel hoisting rope of not less than 60,000 pounds tensile strength, and will be clamped at the ends to the bitts and adjusting screws shown on drawing No. 15.

225. *Character of work.*—The pontons and pipes, and all their parts and fittings, must be of first-class material and workmanship. The pontons must be water-tight, and if found to leak after launching, they must be hauled out of the water by the contractor and made tight to the satisfaction of the engineer officer in charge. The pipes also must be water-tight, and all riveting in pipes must be countersunk on the inside and driven heads flush or very slightly rounded. Rivets on decks of pontons will be flush; rivets on bottoms will be countersunk, and driven heads on outside slightly convex; rivets around the sides will have cup heads outside. The pipes must be perfectly straight when finished; if not so, the contractor will be required to cut them apart, ream out the holes, and put in larger rivets, or otherwise make them good as directed by the engineer officer in charge. All the parts of the ball and socket joints must be finished to gauges and templets in order that the pipes may be interchangeable.

226. *Painting.*—The pontons and pipes will be painted as required by paragraph 239.

MISCELLANEOUS MACHINERY, ETC.

227. *Steam steerer.*—The dredge will be furnished with a steam-steering engine of a make approved by the Engineer officer in charge, installed in a satisfactory manner with all requisite wire ropes, tiller chains, sheaves, leads and blocks, making connections between steering wheel and rudders.

228. *Bilge siphons.*—Two 2½-inch bilge siphons will be placed in each compartment, except the bow wings, which will have one siphon each. All necessary piping, suction shoes, and steam valves conveniently located will be supplied. The discharge will be about 2½ feet above the water line and the outboard ends will terminate with elbows. A 2½-inch siphon for filling and pumping out the discharge pipe will be provided, located as directed, and connected with two pieces of suitable smoothbore hose.

229. *Barge siphons.*—Two 2-inch steam siphons or ejectors will be furnished for pumping out coal barges. These ejectors shall be of approved make and fitted with suction pipes about 9 feet long with strainers, and short discharge pipes; also with a total of 200 feet of 1¼-inch steam pipe in about 15-foot lengths coupled together with extra heavy brass ground joint unions. Steam branch connections will be made on each side of the vessel in convenient locations and provided with shut-off valves. The siphons and pipes will be stowed on suitable racks.

230. Steam heating.—A complete system of heating by low-pressure steam will be installed. About 25 pipe coil radiators will be required, the length and number of returns being determined by the location, number of radiators, and size of the rooms to be heated. A reducing valve to reduce the steam pressure to 20 pounds per square inch and a safety valve will be conveniently located in the engine room, and all requisite radiator valves, air cocks, steam traps, drainpipes, and protecting screens for all woodwork will be supplied. The drains will deliver to the hotwell and the whole system will be set up in a thoroughly workmanlike manner and neatly finished.

231. Ice crane.—A small jib with eyebolt at the end for tackle blocks will be put up under the hurricane deck as indicated on drawing No. 3. A hatchway with cover for same will be provided in the boiler deck over the freezing tank, for taking ice to the kitchen.

232. Stores crane and hatchway.—A hatchway for passing heavy stores from main to boiler deck will be provided, as shown on drawing No. 3, and a jib for tackle blocks similar to that specified in paragraph 231 will be put up under the hurricane deck, as indicated.

233. Lifeboats and davits.—The davits for lifeboats will be located on the main deck guards at the after end of the boiler house. They will be hinged to the deck and will fall outwards a sufficient distance to enable boats to clear the nosing. The davits will be rigged with a device for raising and lowering and with all necessary tackle blocks and falls for handling the boats. Two metallic lifeboats will be provided, 18 feet long, 5½ feet wide, and 2 feet 3 inches deep, having a carrying capacity of 19 persons. These boats must conform in all respects to the requirements of the Board of Supervising Inspectors of Steam Vessels, and must be provided with suitable paulins to protect them from the weather.

234. Hydraulic piles.—The dredge will be supplied with 20 piles 11 inches outside diameter and 35 feet long, made in two sections, the lower part to be 20 feet long, of tube three-fourths inch thick, and the upper part 15 feet long, of tube one-half inch thick. The parts will be joined together with heavy cast-steel flanges shrunk or pressed on and riveted; the top end to be closed by a steel cap having a lifting eye cast on, riveted in place and calked water-tight. The coupling flanges will be accurately bored to gauge and finished on the faces. Near the upper end of each pile there will be a hole tapped with 2½-inch pipe thread and fitted with extra strong nipples and malleable elbow.

235. Anchors.—Two patent stockless anchors of approved design will be supplied, each anchor to weigh about 800 pounds.

236. Drip pans, oil guards, and hand rails.—All engines will be provided with oil guards and drip pans, and pumps with drip pans and drain pipes where required. Hand rails will be placed about machinery where required.

237. Extra parts of machinery.—In addition to the extra parts called for in sundry foregoing paragraphs of these specifications, there will be required the following: 1 bronze worm for each of the hauling winches, 1 pair of brasses for the small end of each connecting rod of main pump engines, 1 pair of brasses for the small end of each connecting rod of propelling engines, 1 pair of brasses for each end of each connecting rod of jet pump engine, 2 bushes (in halves) for the glands of the main pump shaft, 20 grate bars for boilers.

Of the above extra parts, the worms will be finished and fitted to their respective shafts; the remainder will be furnished in the rough.

238. Patterns.—The following patterns will be furnished, in good order and condition, ready for use, including all core boxes required: Patterns for all the main pump liner plates, patterns for steel lip at discharge port of pump casing, patterns for the wearing rings on casing and runner of main pump, together with the chill casting for same, patterns for the throat rings at suction of main pump casing, patterns for the independent blades of main pump runner, patterns for the jet nozzles for suction head, 3 patterns for grate bar, 1 pattern for each different furnace mouthpiece.

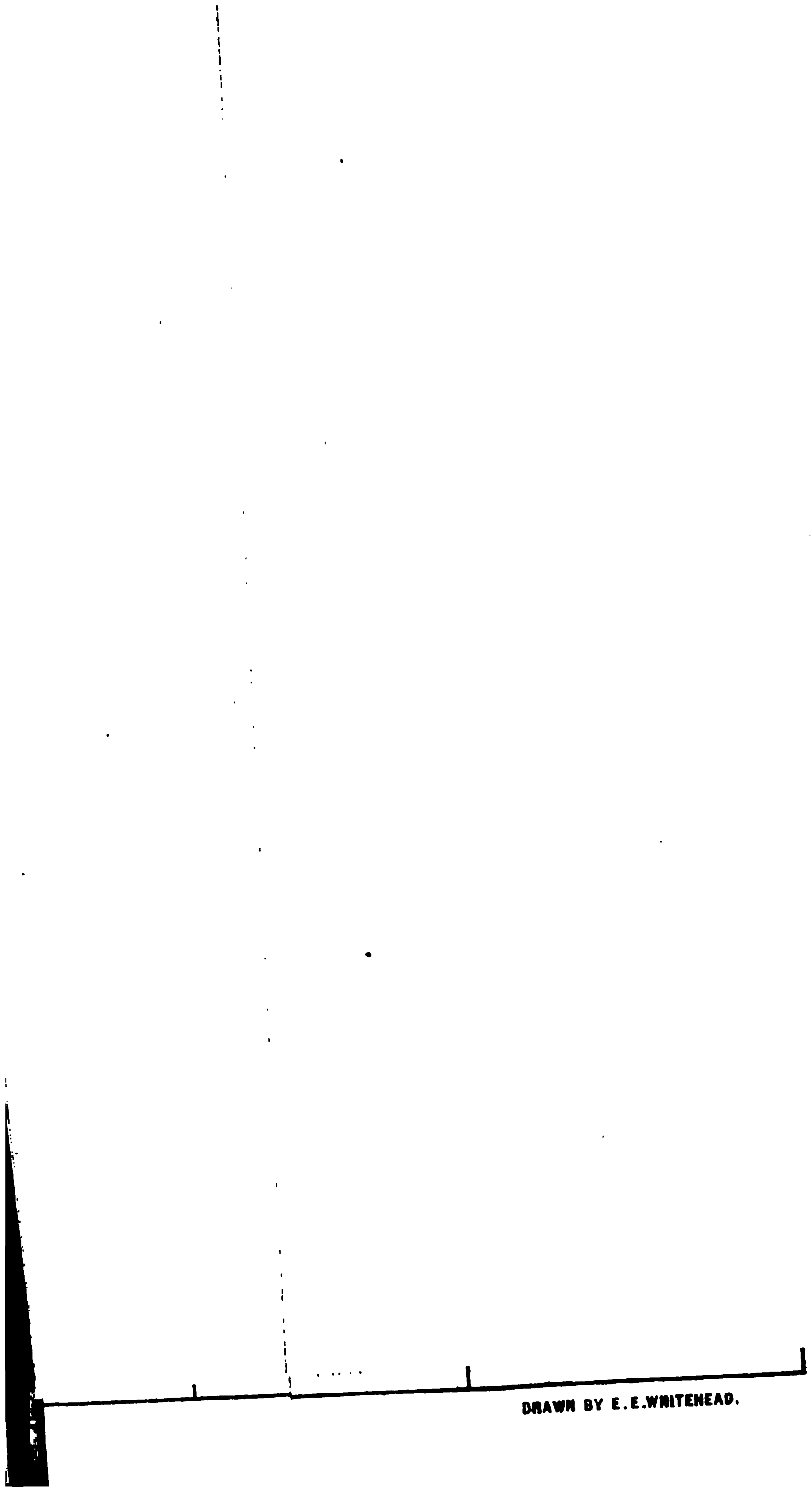
PAINTING.

239. Hull and pipe line.—All contact surfaces in structural work throughout the dredge and its accessories will receive a good coat of red lead and oil before being riveted together. All metal surfaces will be thoroughly cleaned from scales, grease, and oxidation before the first coat of paint is applied. The exterior of the hull will be cleaned with a sand blast, all mill scales removed, and the first coat of paint promptly applied, before the cleaned surface has time to oxidize. The paint will be pure red lead mixed in pure linseed oil in the ratio of 5 pounds of oil to 18 pounds of red lead. The red lead must be first thoroughly mixed with enough linseed oil to form a thick paste, which will keep for several days without hardening. This as needed for use, must be thinned down to the proper consistency for spre with pure linseed oil, and applied immediately; paint left in the cans at close day's work shall not be used. The exterior of the hull will receive three coats lead and oil as described, and all blocking shall be moved as required for pa the surfaces covered, giving ample time for such places to become thorough before the launching takes place. The pontons and pipe line shall be paint same manner as exterior of the hull. The interior of the hull shall be thoro cleaned of dirt of every description, and given a coat of red lead and oil prep above, put on as the work progresses. Two coats of best white lead and oil sh afterwards applied; the first after the hull is completed, launched, and found factorily water-tight; the second after all the machinery is in place and the d completed and otherwise ready for testing.

240. Machinery and metal work shall be painted one coat of lead-color paint b leaving the works of the manufacturer. When the dredge is otherwise comp all machinery and metal work will receive two coats of good paint of such m and color for the several parts as the engineer officer in charge may deter This painting may be completed before the testing of the dredge, but any dam paint on either machinery or woodwork shall be made good before the dredge be accepted.

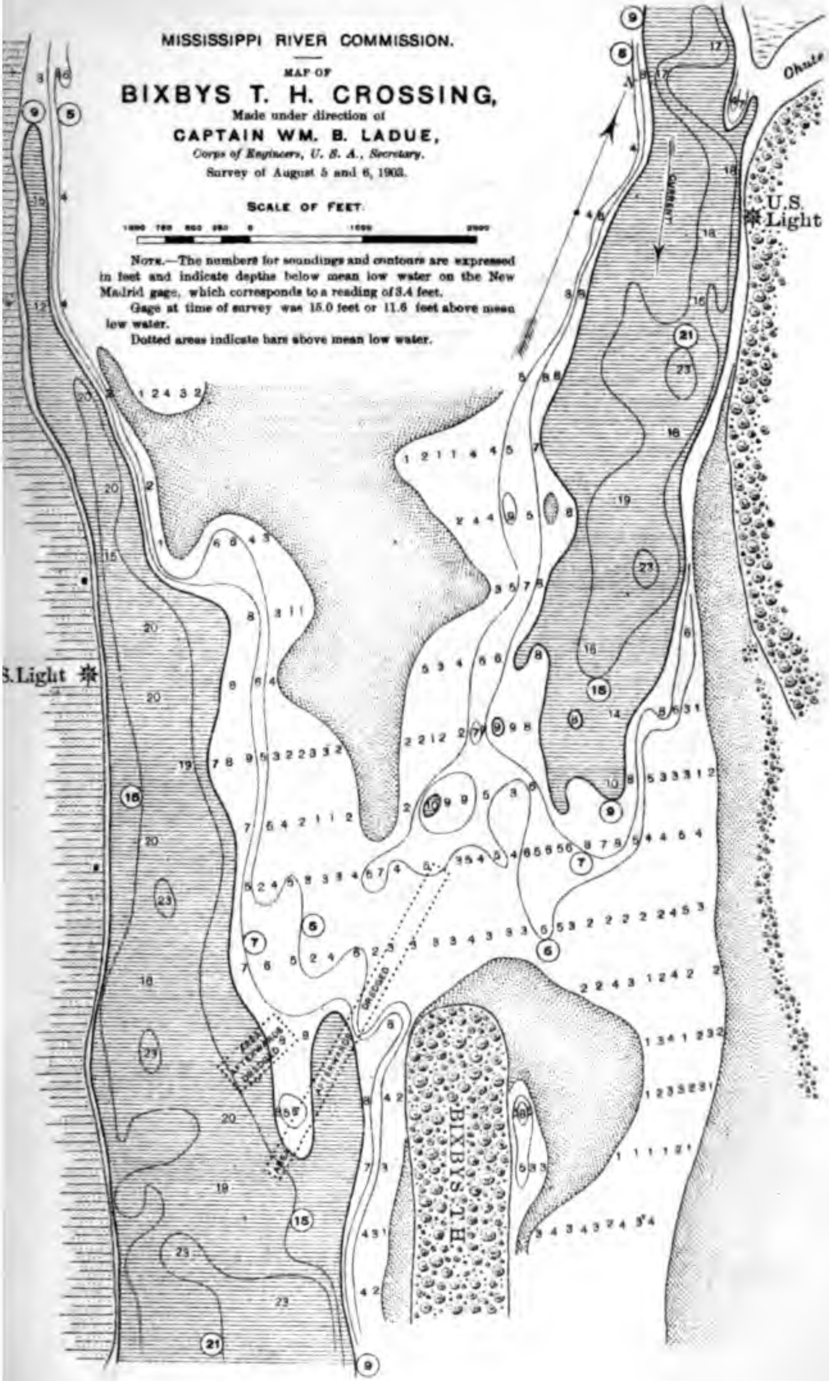
241. Cabins and upper works.—All the woodwork shall be painted in a thoro first-class manner, to the satisfaction of the engineer officer in charge. The m rials used shall be of the brand, grade, or quality hereinafter specified, and sha delivered on board the vessel in unbroken original packages, bearing the ma name or trade-mark; and shall be open to inspection or test at any time tha engineer officer in charge or his appointed agent may desire. The work sha free from lumps or runs, each coat except the last sandpapered before next c applied, and all open joints in deck or roof filled. All woodwork shall be pro primed as soon as possible after being put in place. The whole of the work a the boiler deck except the upper sides of roofs shall be primed with one good of shellac; all knots to receive an additional coat of shellac; all nail heads and holes to be filled, and rough surfaces sandpapered. Special care must be taken to vent the warping of panels and other light work. The main deck house, both side and inside, will be painted three coats of white lead and linseed oil with a quantity of japan dryer. The last coat will be tinted with lampblack for such of the siding, doorways, etc., as will be determined. The coal bunker shea will be painted two coats of good mineral paint. The underside of boiler deck be painted three coats of white lead thinned with one part of turpentine and part of boiled linseed oil, the last coat to be tinted yellow stone color, or such as may be selected. The outside of all cabins on boiler deck, the outside of sky and pilot house, all railings and nosings, spars, and flag poles will be painted coats of white lead thinned with raw linseed oil with a small quantity of japan d All outside doors and door blinds will be tinted with yellow stone color, or other as may be selected. The caps of hand rails will be tinted with lampb The underside of hurricane deck outside of the cabins, and the ceiling of pilot h will be painted three coats; the first coat to be white lead thinned with three of turpentine to one part of boiled linseed oil; the second and third coats to be quality green paint of such shade as shall be selected. The underside of the pro ing parts of skylight and pilot-house roofs will be painted three coats of white thinned with one part of turpentine to one part of linseed oil.

The inside of office and saloon will be painted four coats; the first to be white thinned with boiled linseed oil and turpentine in such proportions as shall be d mined, the second and third coats to be of white zinc in oil thinned with clear pentine, the fourth coat to be of white zinc ground in Dammar Varnish, thinned Crystal Dammar Varnish. The inside of the staterooms in forward section of will be painted three coats, the first and second coats to be white lead thinned three parts turpentine and one part boiled linseed oil, and the third coat to be proportions of white lead and white zinc thinned with turpentine. The balan the woodwork inside will be painted four coats, the first and second coats to be lead thinned with turpentine and boiled linseed oil in equal proportions, the coat to be white lead thinned with turpentine only, and the fourth coat to be i coach varnish. Such parts of kitchen and crew's mess room and quarters as m desired will be tinted with lampblack. The treads of all steps and stairs wi painted with a suitable filler, rubbed down with fine sandpaper, and painted coat best "Elastic Spar Varnish." The name of the vessel will be put on the boards on the pilot house in gilt letters 10 inches high, on a dead black ground molding will be painted vermilion, three coats. The name will be also paint



DRAWN BY E.E.WHITEHEAD.

Plate 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

BIXBYS T. H. CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

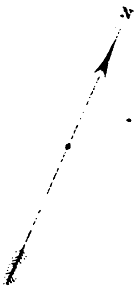
Survey of August 5 and 6, 1903.

SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 15.0 feet or 11.6 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

BIXBYS T. H. CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 25, 1903.

THREE DAYS BEFORE DREDGING BY HENRY FLAD—FIRST TIME.

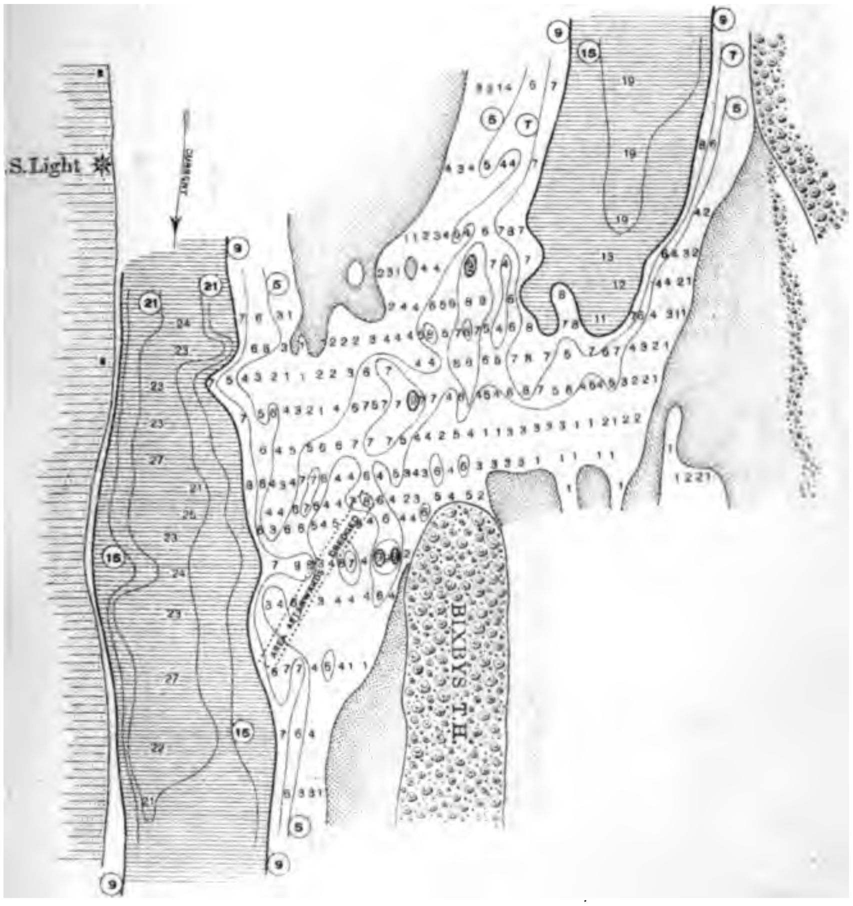
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 14.1 feet or 10.7 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

BIXBYS T. H. CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 3, 1908.

DURING DREDGING BY HENRY FLAD—FIRST TIME.

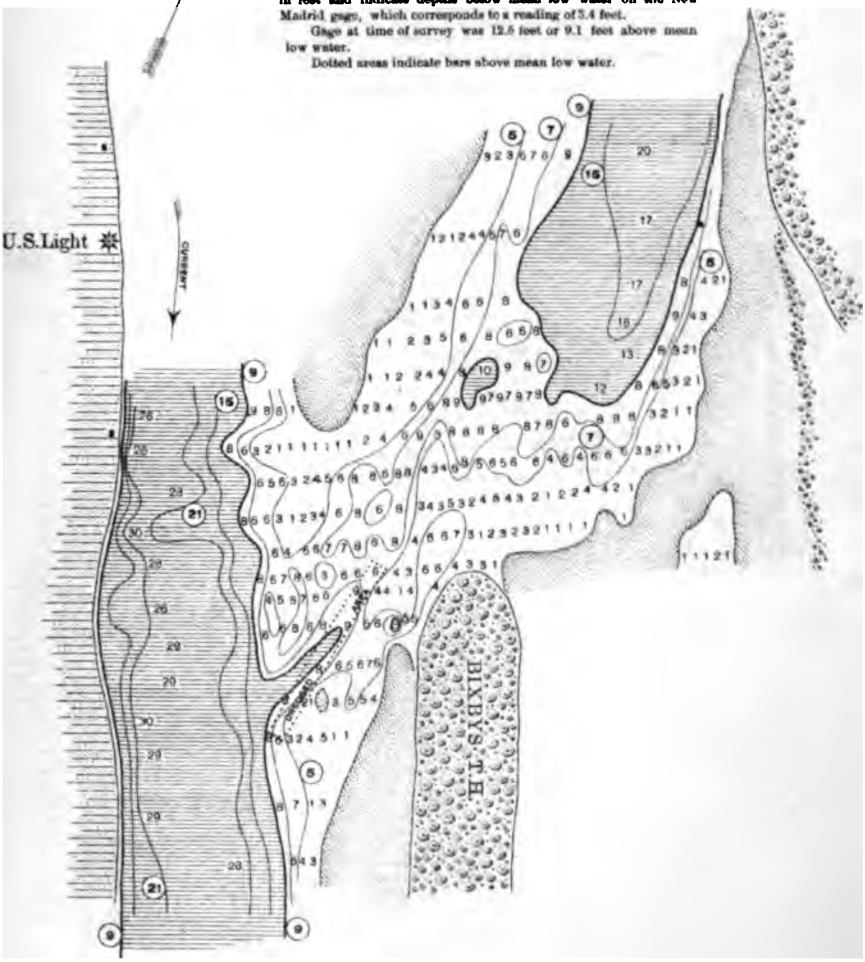
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 12.5 feet or 9.1 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

BIXBYS T. H. CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 10, 1908.

JUST AFTER DREDGING BY HENRY FLAD—FIRST TIME.

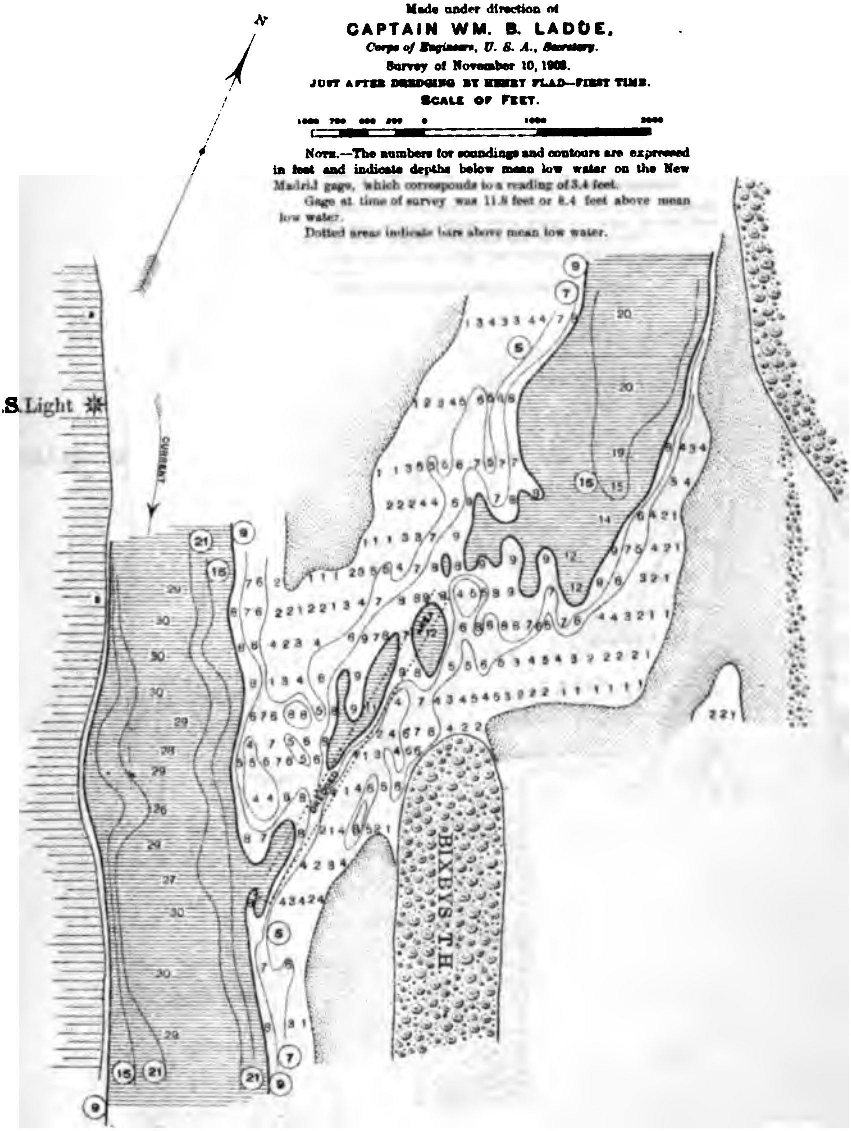
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 11.8 feet or 8.4 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

BIXBYS T. H. CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 24, 1903.

JUST AFTER DREDGING BY HENRY FLAD—SECOND TIME.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 9.3 feet or 5.9 feet above mean low water.

Dotted areas indicate bars above mean low water.

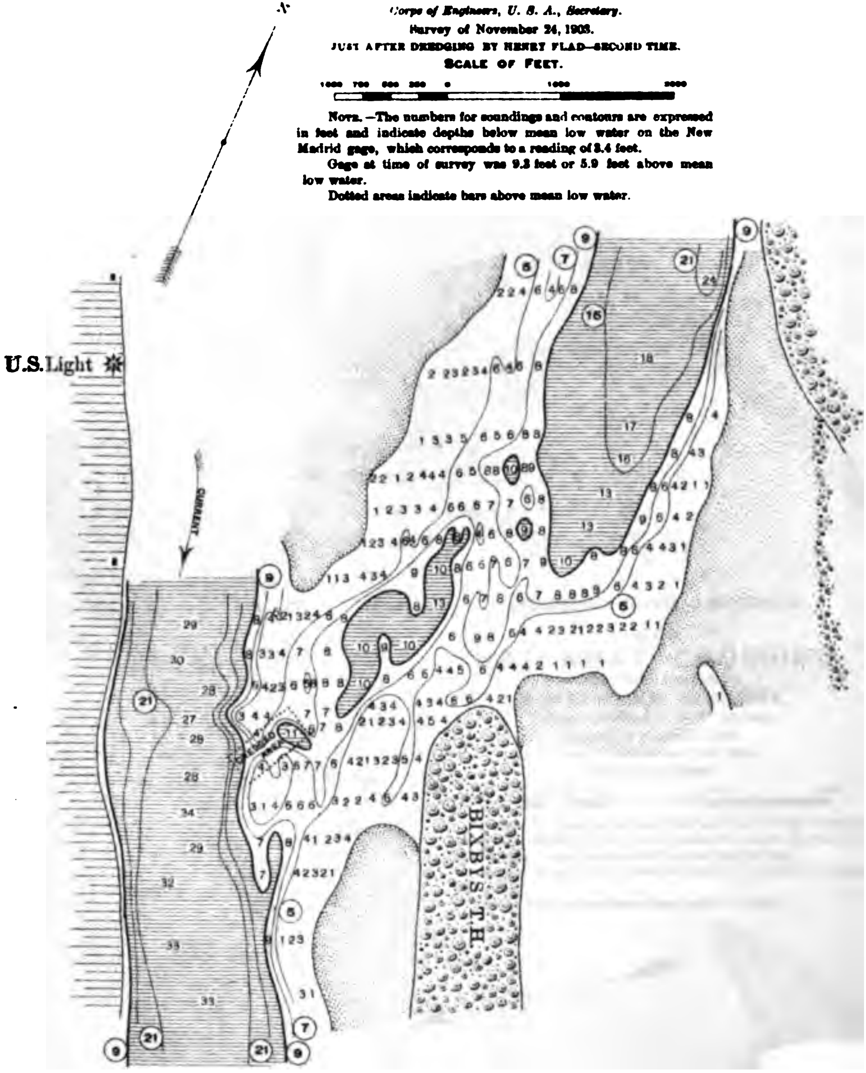
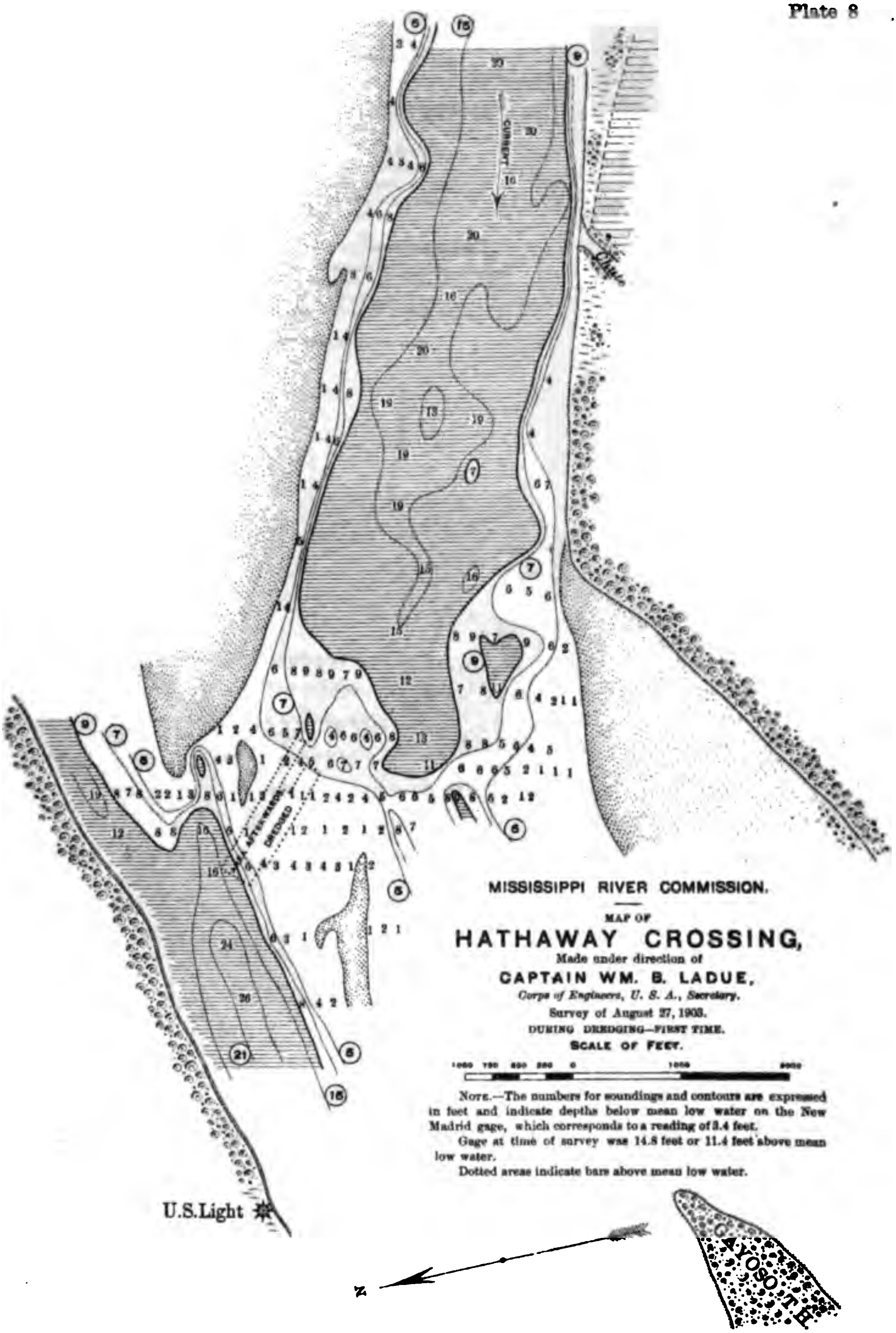


Plate 8



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATHAWAY CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of August 27, 1903.

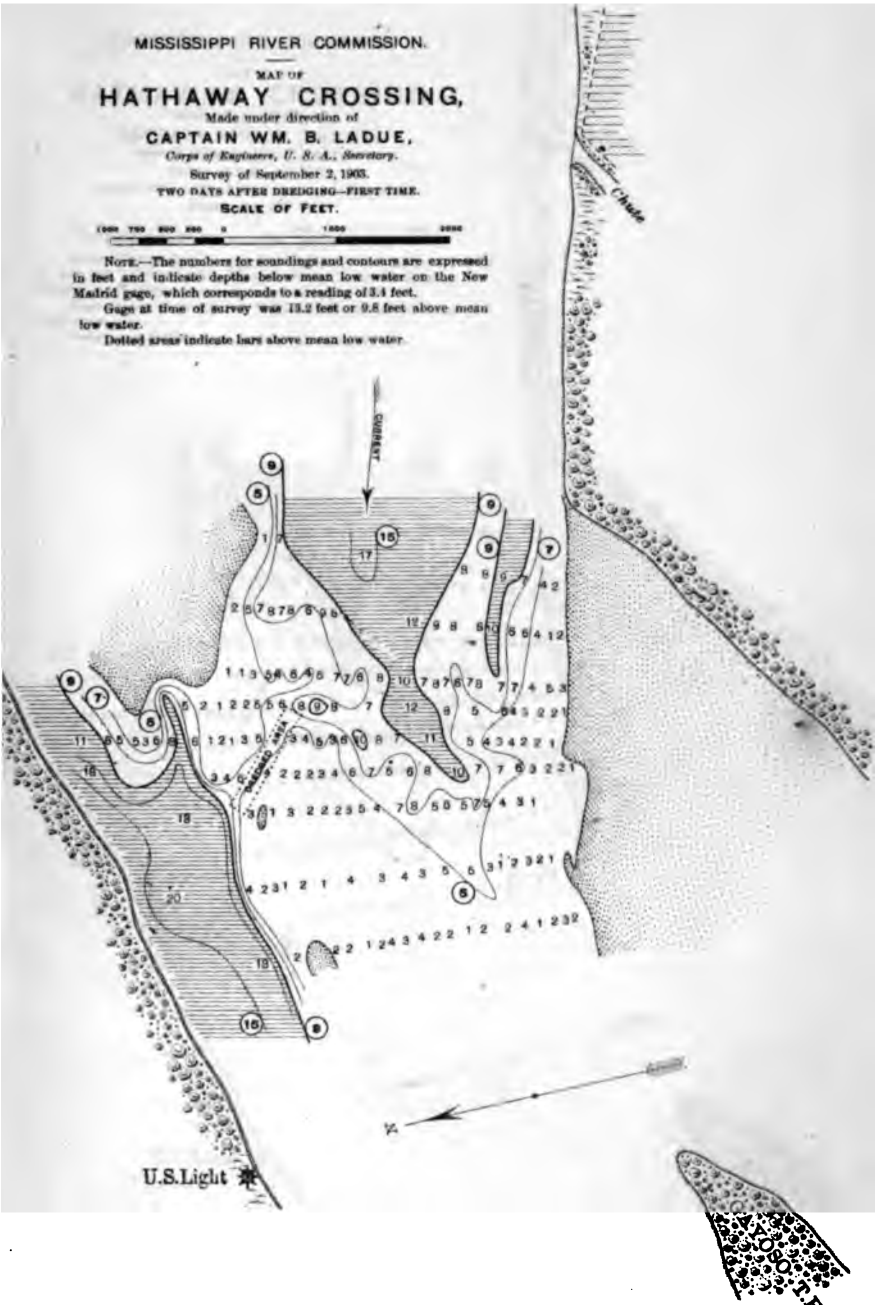
DURING DREDGING—FIRST TIME.

SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 14.8 feet or 11.4 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATHAWAY CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 2, 1903.

TWO DAYS AFTER DREDGING—FIRST TIME.

SCALE OF FEET.

Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 13.2 feet or 9.8 feet above mean low water.

Dotted areas indicate bars above mean low water.

Plate 10

MISSISSIPPI RIVER COMMISSION.

MAP OF

HATHAWAY CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 2, 1908.

THIRTY-TWO DAYS AFTER DREDGING—FIRST TIME.

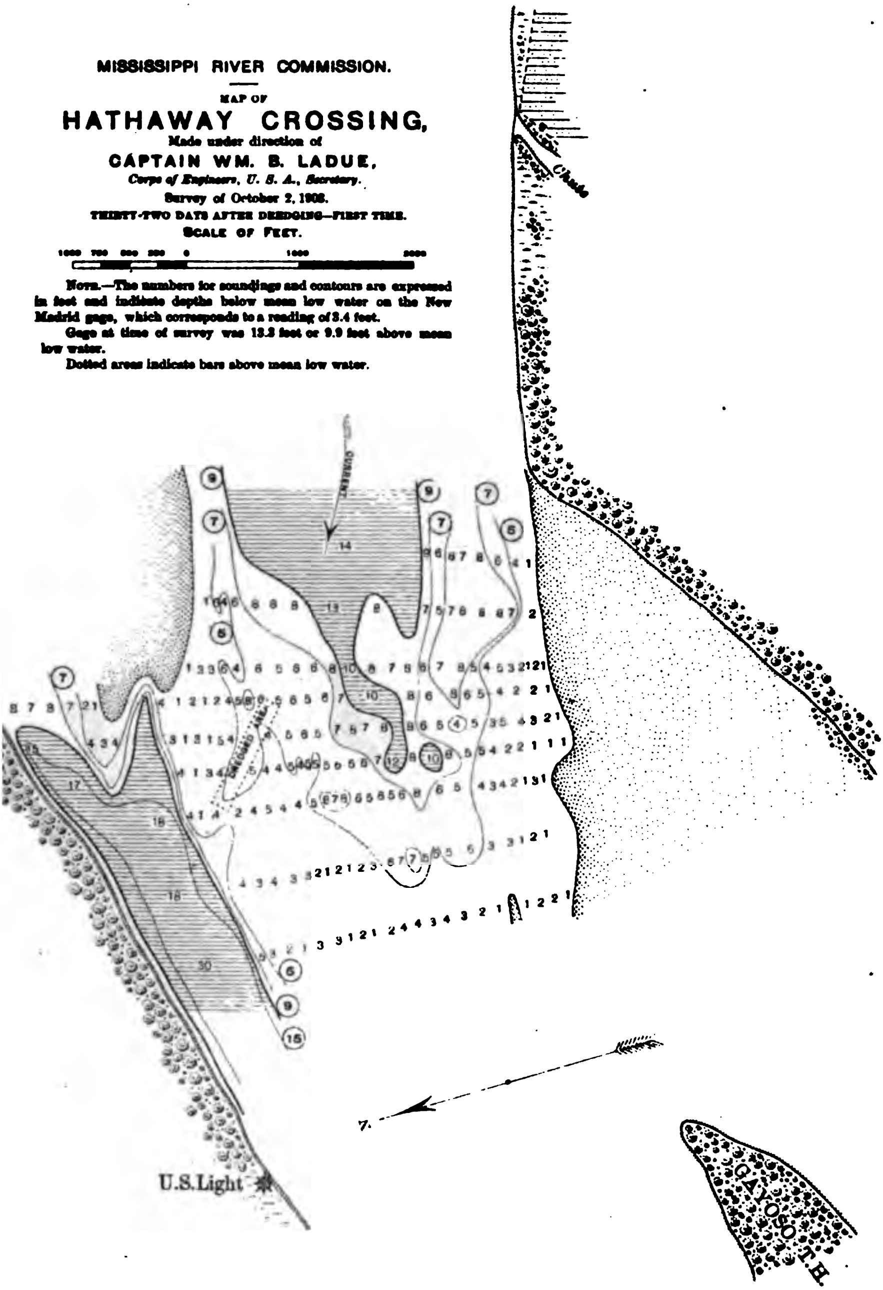
SCALE OF FEET.

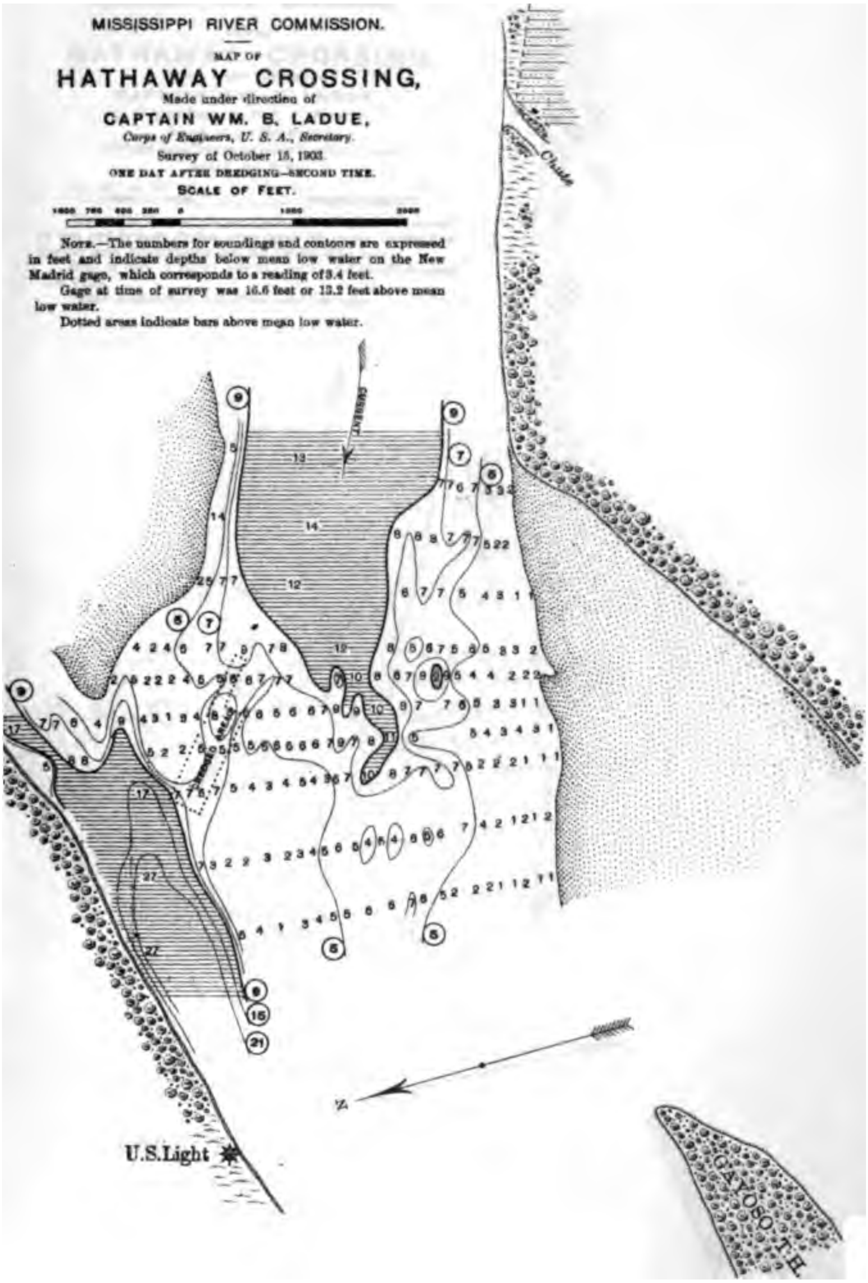
1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 13.3 feet or 9.9 feet above mean low water.

Dotted areas indicate bars above mean low water.





MISSISSIPPI RIVER COMMISSION.

MAP OF

HATHAWAY CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 15, 1903.

ONE DAY AFTER DREDGING—SECOND TIME.

SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 16.6 feet or 13.2 feet above mean low water.

Dotted areas indicate bars above mean low water.

MISSISSIPPI RIVER COMMISSION.

MAP OF

HATHAWAY CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 29, 1903.

FIFTEEN DAYS AFTER DREDGING—SECOND TIME.

SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 13.4 feet or 10.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

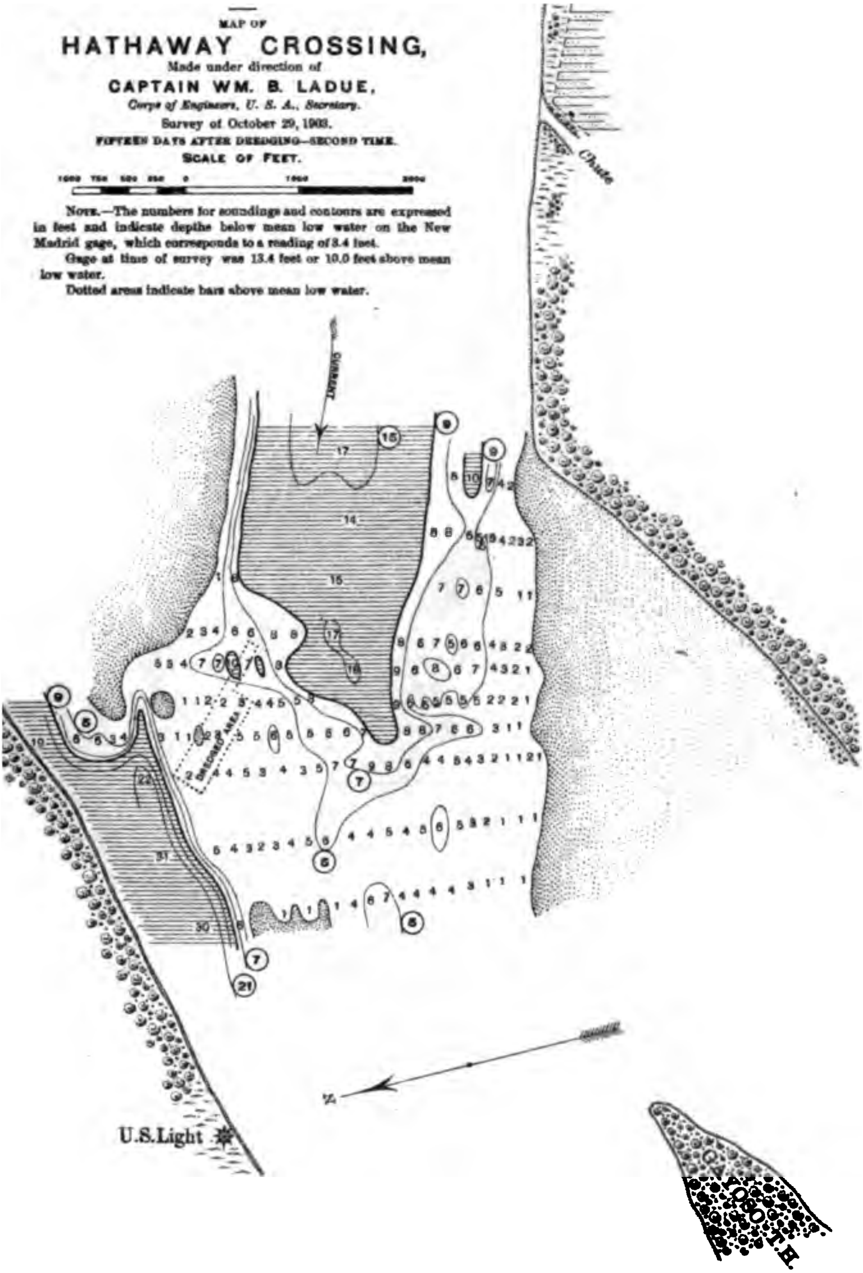


Plate 13

MISSISSIPPI RIVER COMMISSION.

MAP OF

HATHAWAY CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 14, 1908.

JUST AFTER DREDGING—THIRD TIME.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 11.7 feet or 8.3 feet above mean low water.

Dotted areas indicate bars above mean low water.

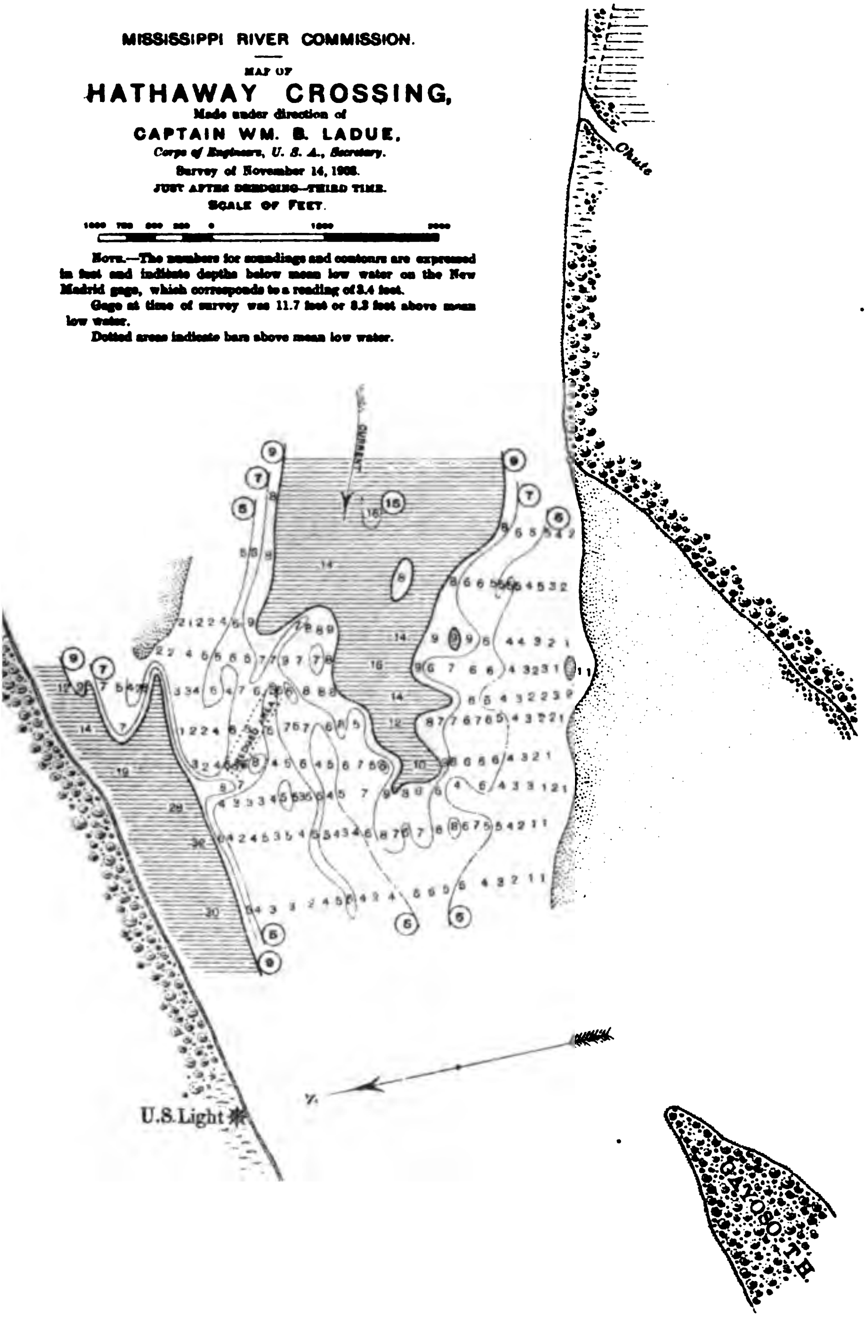
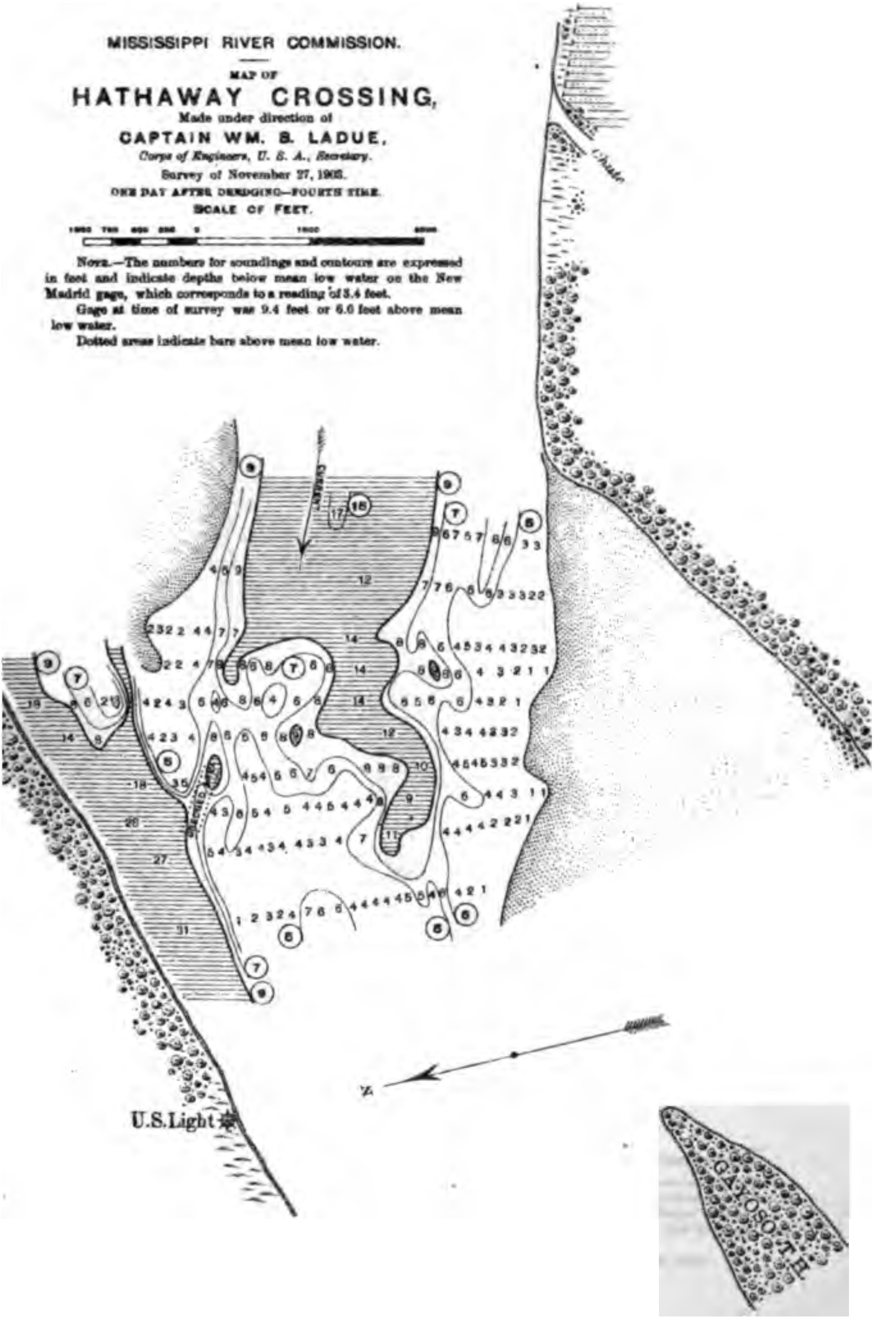


Plate 14



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATHAWAY CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 27, 1905.

ONE DAY AFTER DREDGING—FOURTH TIME.

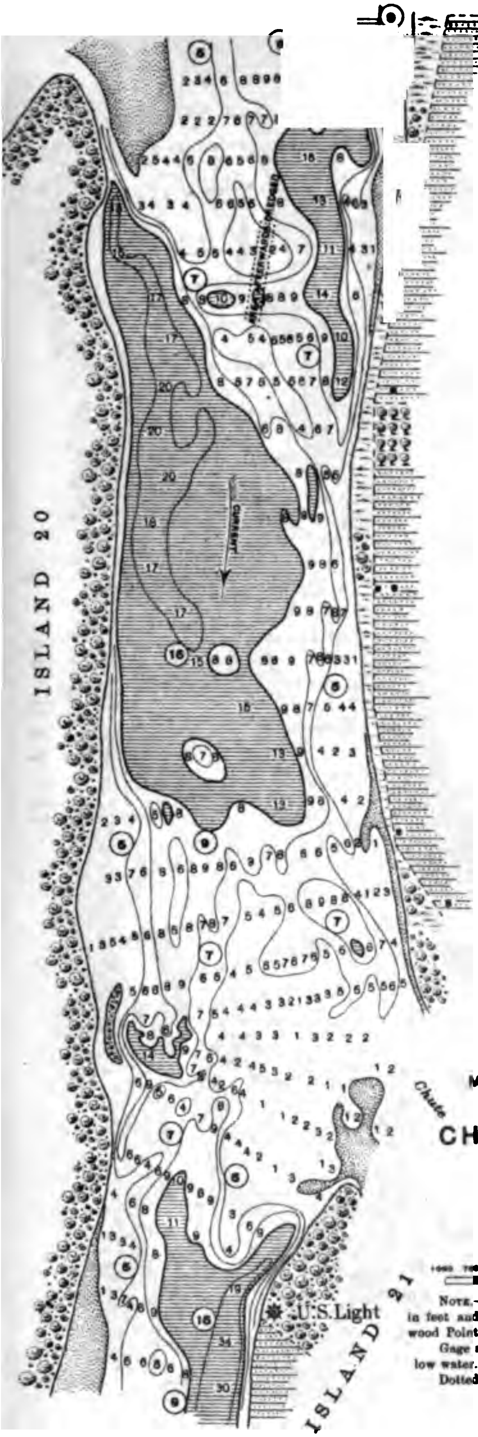
SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 9.4 feet or 6.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Plate 15



MISSISSIPPI RIVER COMMISSION.

MAP OF

CHUTE OF ISLAND 20,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 29, 1908.

TEN DAYS BEFORE DREDGING

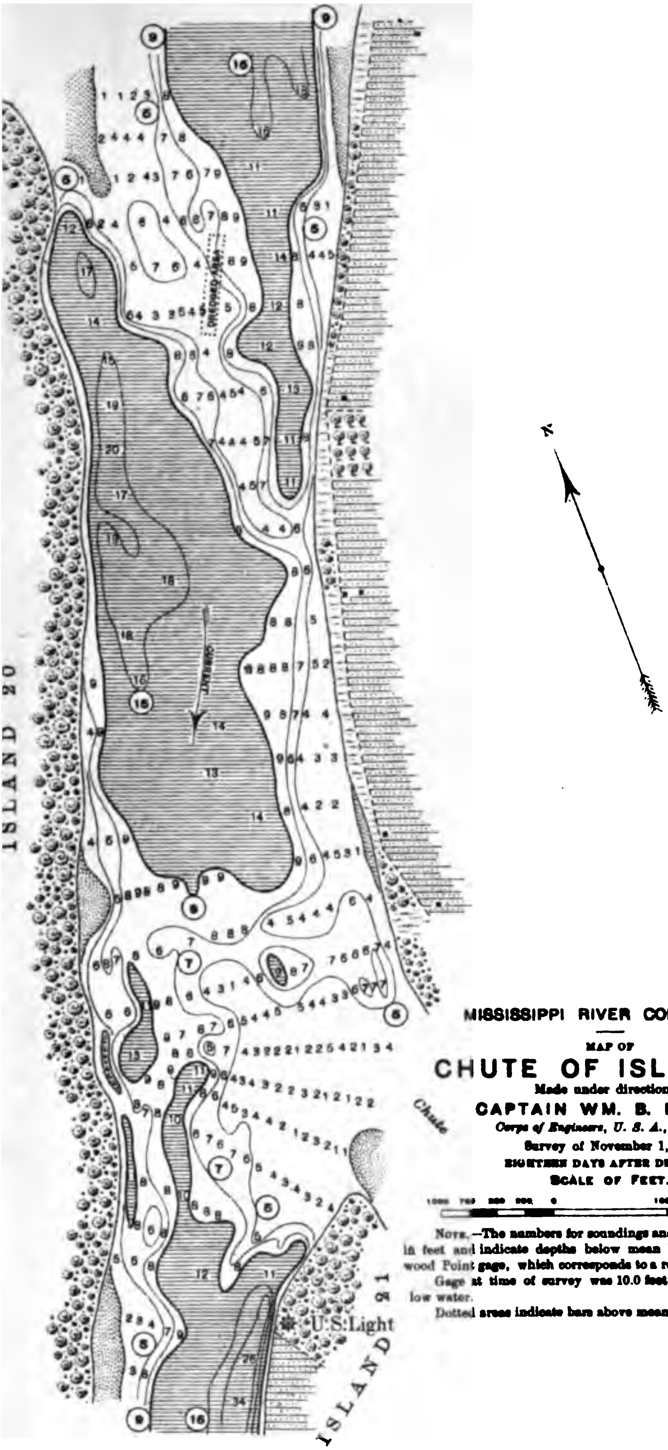
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.5 foot.

Gage at time of survey was 11.0 feet or 10.5 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

CHUTE OF ISLAND 20,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 1, 1908.

EIGHTEEN DAYS AFTER DREDGING.

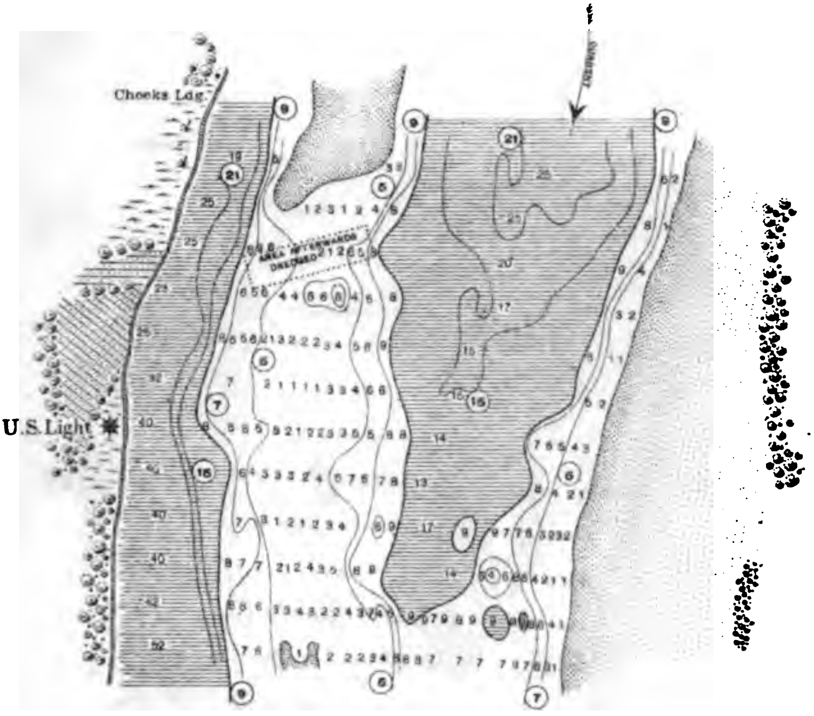
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.5 foot.

Gage at time of survey was 10.0 feet or 9.5 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

FOOT OF ISLAND 21 CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 30, 1908.

TWO DAYS BEFORE DREDGING.

SCALE OF FEET.

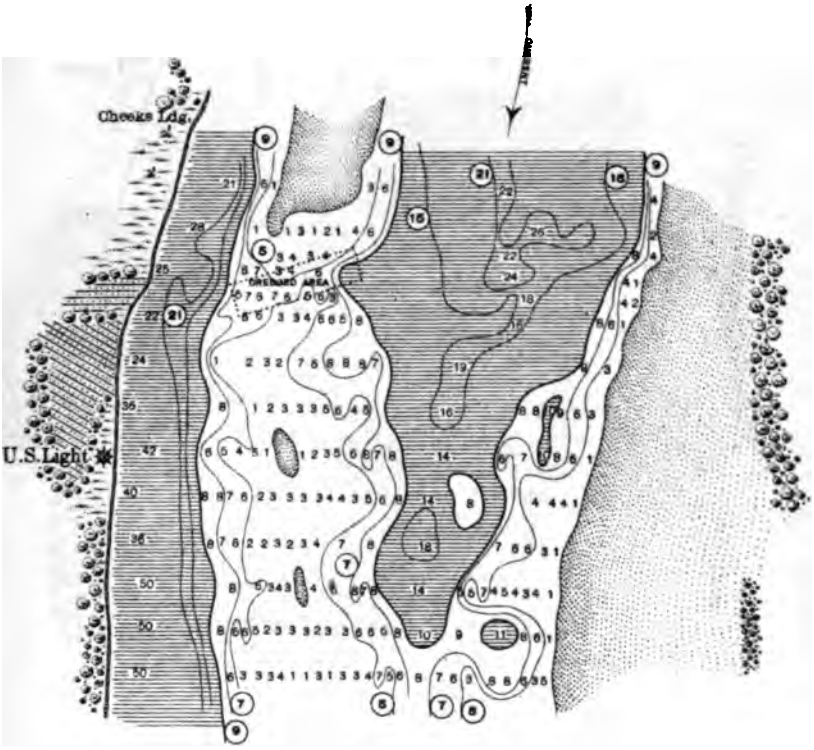
1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.5 foot.

Gage at time of survey was 10.5 feet or 10.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Plate 18



MISSISSIPPI RIVER COMMISSION.

MAP OF

FOOT OF ISLAND 21 CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 10, 1908.

SIX DAYS AFTER DREDGING.

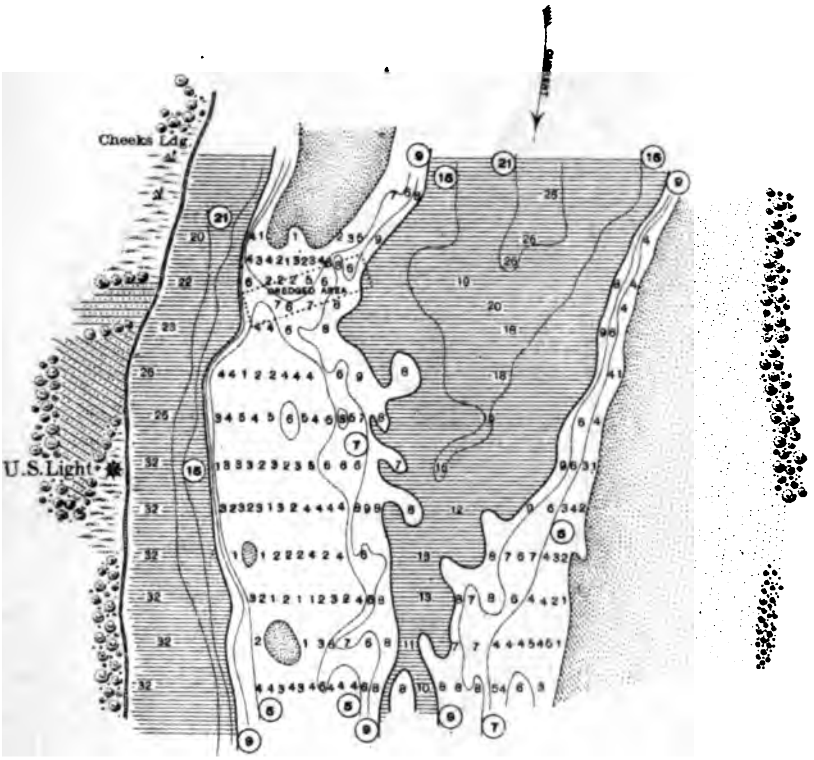
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.5 foot.

Gage at time of survey was 11.0 feet or 10.5 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

FOOT OF ISLAND 21 CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 16, 1908.

FORTY-THREE DAYS AFTER DREDGING.

SCALE OF FEET.

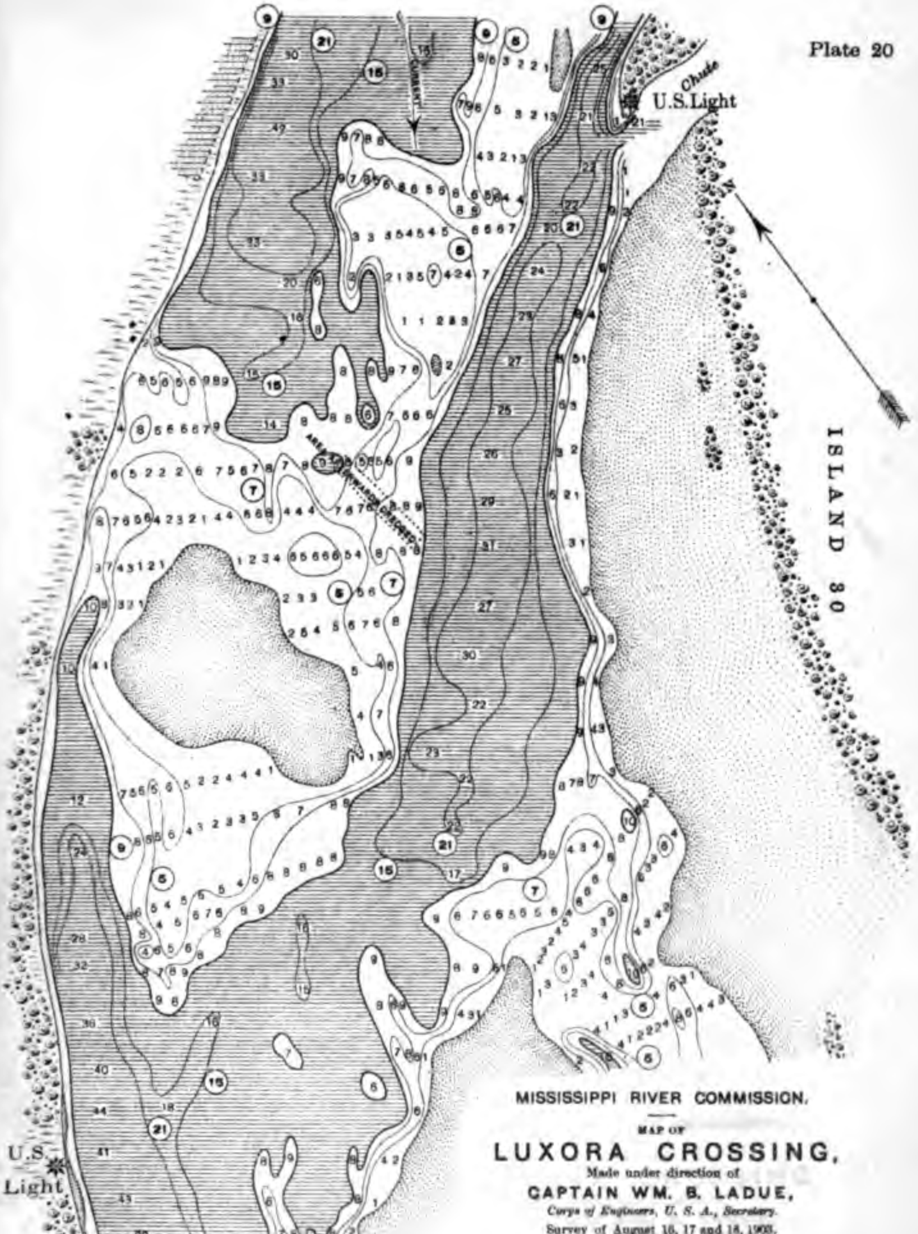
1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.5 foot.

Gage at time of survey was 8.5 feet or 8.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Plate 20



MISSISSIPPI RIVER COMMISSION.

MAP OF

LUXORA CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of August 16, 17 and 18, 1903.

TWENTY-SIX DAYS BEFORE DREDGING.

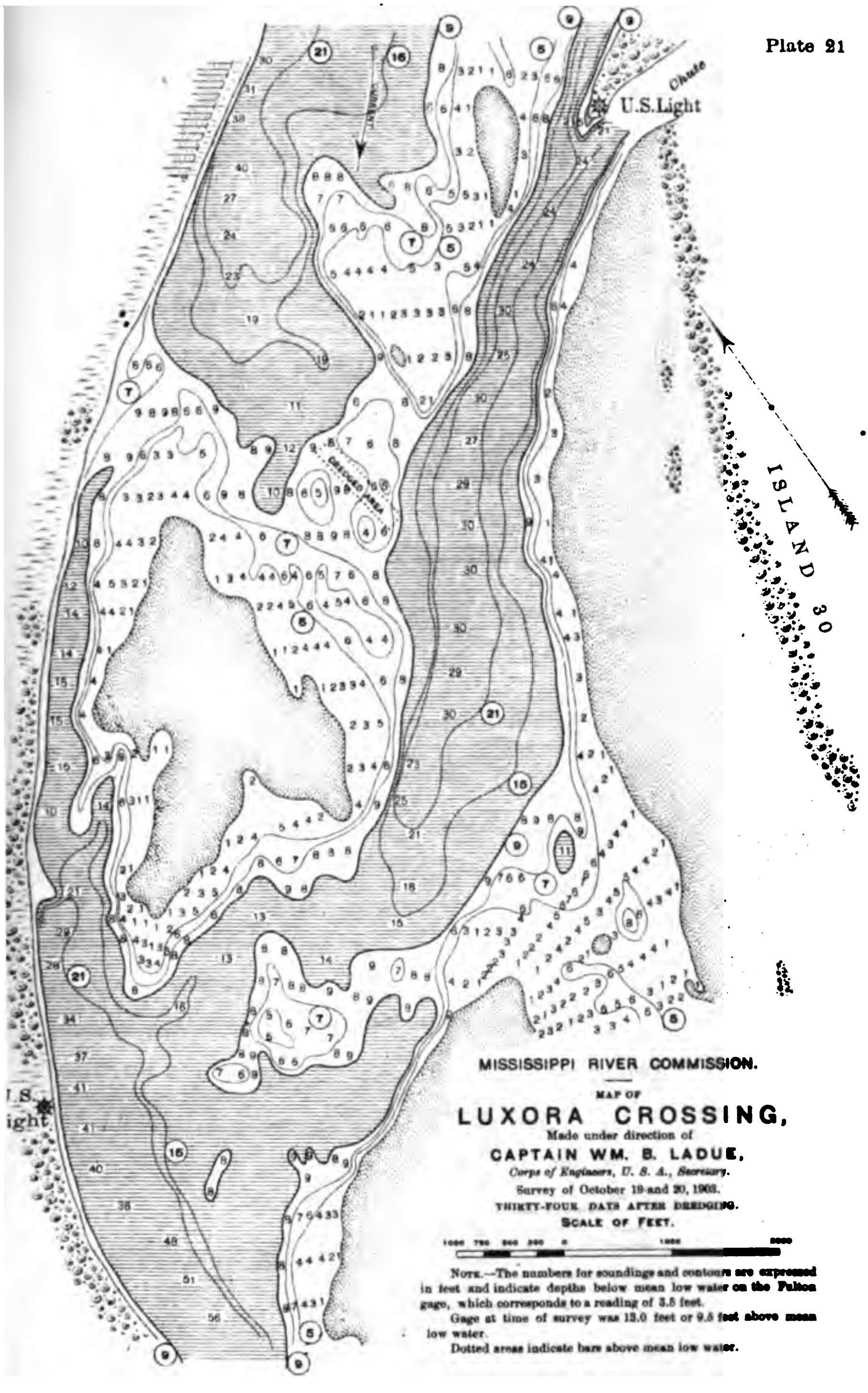
SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.5 feet.

Gage at time of survey was 13.0 feet or 9.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

Plate 21



MISSISSIPPI RIVER COMMISSION.

MAP OF

LUXORA CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 19 and 20, 1903.

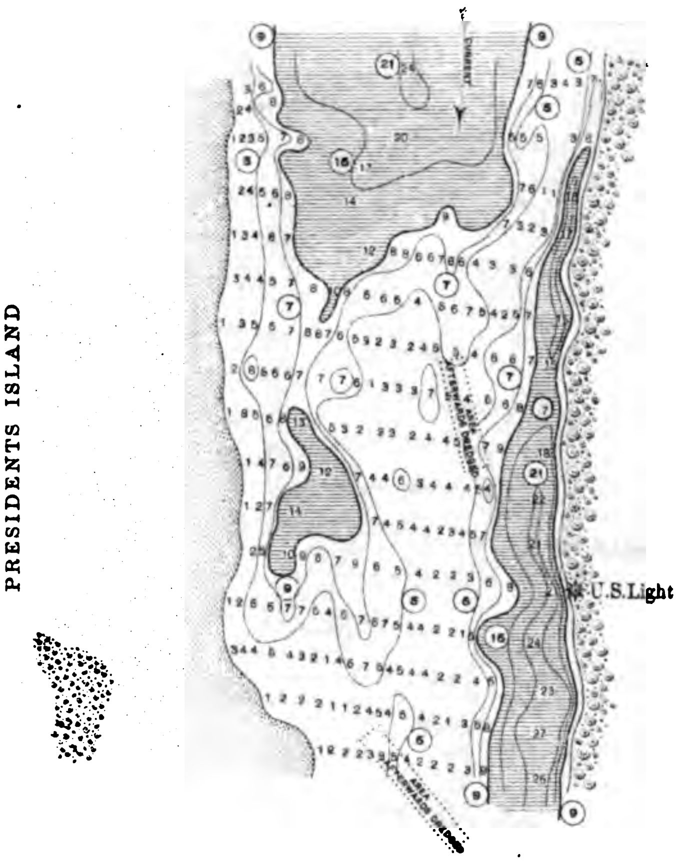
THIRTY-FOUR DAYS AFTER DREDGING.

SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.5 feet.

Gage at time of survey was 13.0 feet or 9.5 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 10 and 11, 1906.

TWENTY-EIGHT DAYS BEFORE DREDGING FIRST TIME.

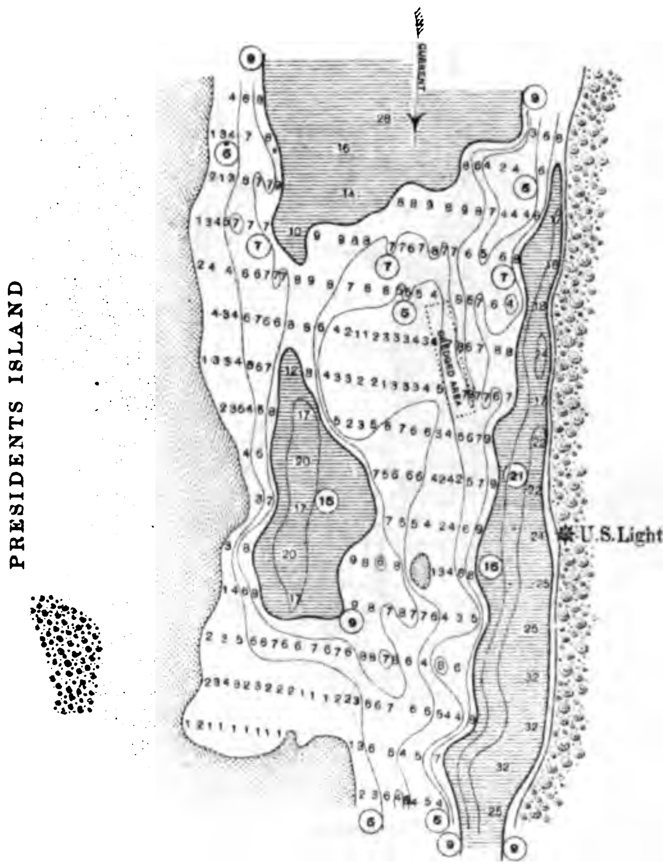
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 0.9 foot.

Gage at time of survey was 11.5 feet or 10.6 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 2, 1908.

TWO DAYS BEFORE DREDGING SECOND TIME.

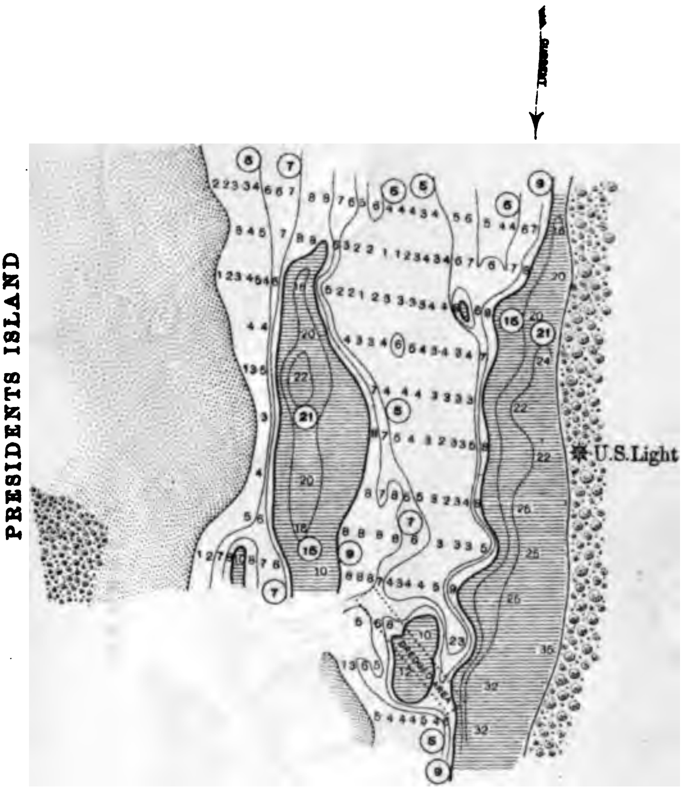
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 0.9 foot.

Gage at time of survey was 9.2 feet or 8.3 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 18, 1908.

ONE DAY AFTER DREDGING SECOND TIME.

SCALE OF FEET.

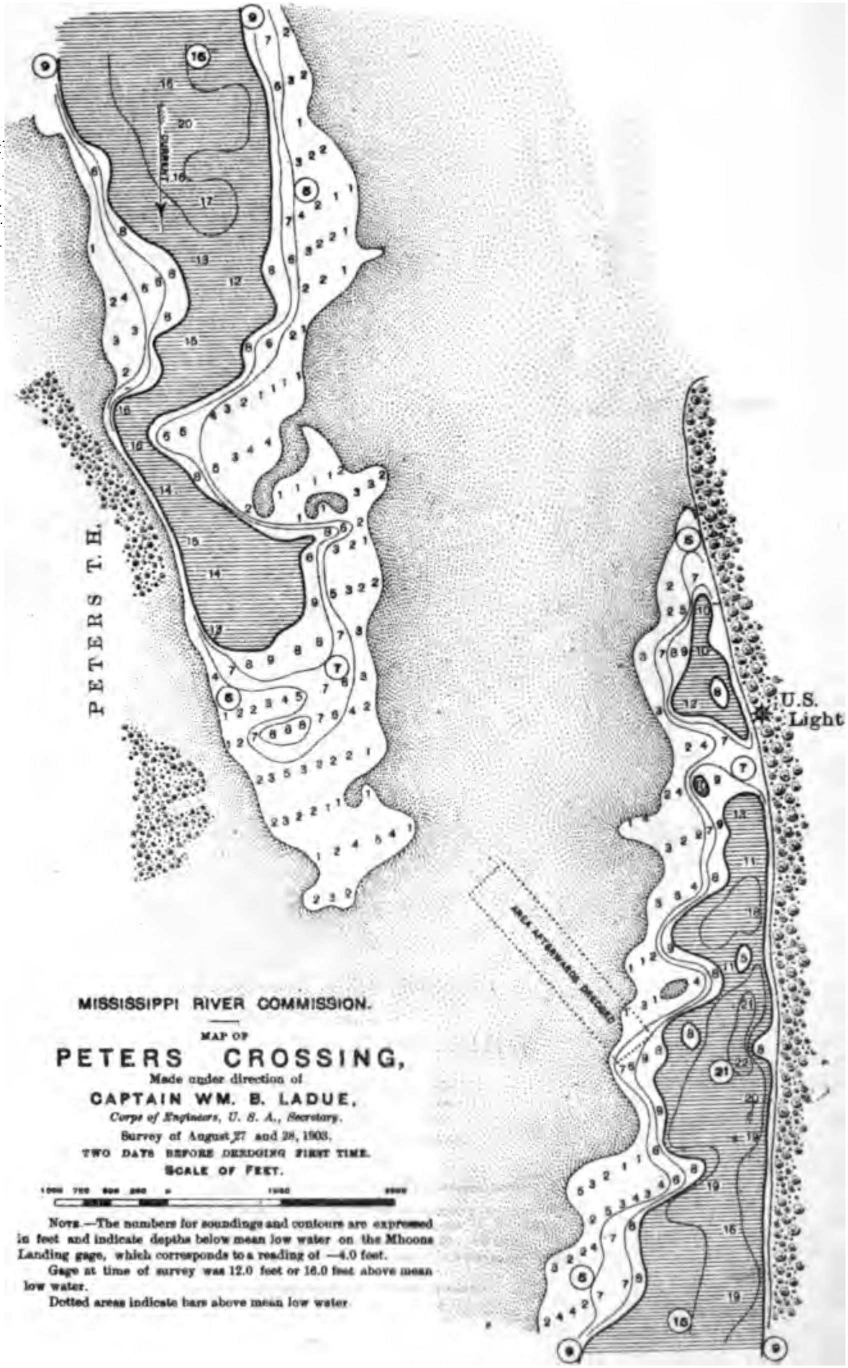
1000 750 500 250 0 1000 2000

Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 0.9 foot.

Gage at time of survey was 7.4 feet or 6.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

Plate 25



MISSISSIPPI RIVER COMMISSION.

MAP OF

PETERS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of August 27 and 28, 1903.

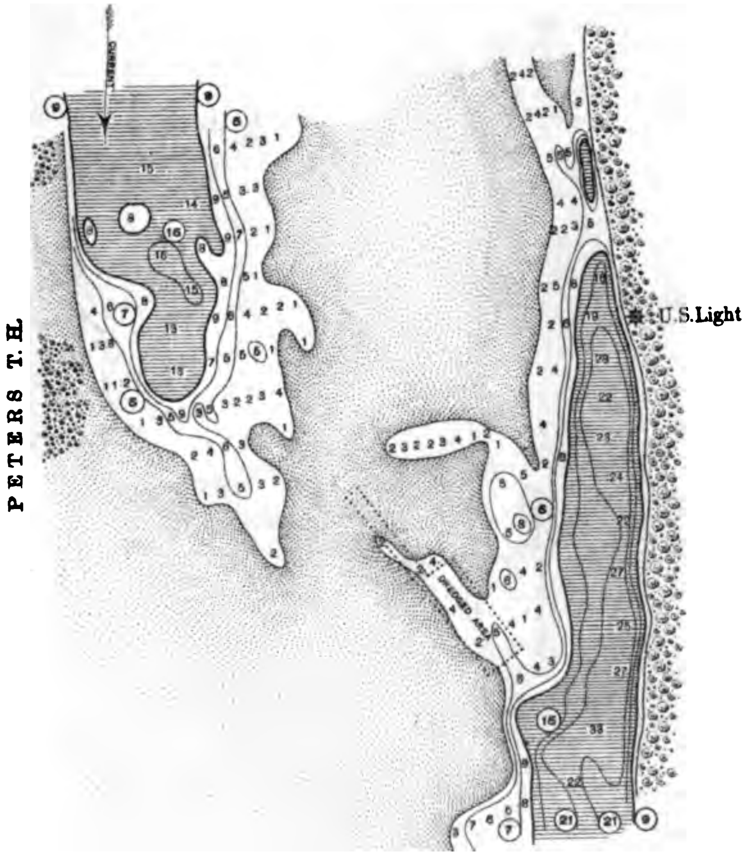
TWO DAYS BEFORE DREDGING FIRST TIME.

SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Mhoons Landing gage, which corresponds to a reading of —4.0 feet.

Gage at time of survey was 12.0 feet or 16.0 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PETERS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 5, 1908.

DURING DREDGING FIRST TIME.

SCALE OF FEET.

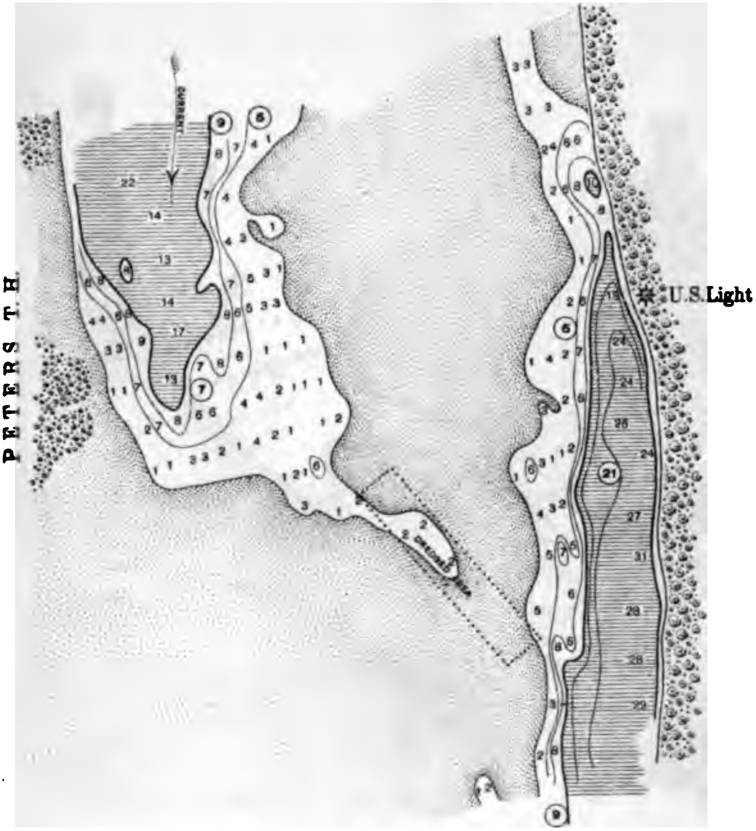
1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Mhoons Landing gage, which corresponds to a reading of —4.0 feet.

Gage at time of survey was 10.8 feet or 14.8 feet above mean low water.

Dotted areas indicate bars above mean low water.

Plate 27



MISSISSIPPI RIVER COMMISSION.

MAP OF

PETERS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 26, 1903.

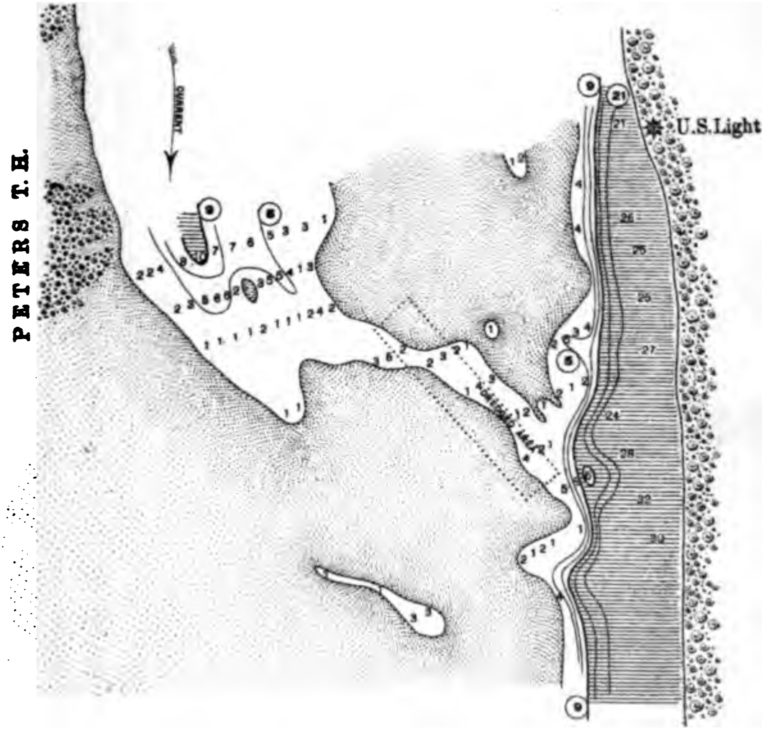
TWO DAYS BEFORE DREDGING SECOND TIME.

SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Mhoon Landing gage, which corresponds to a reading of —4.0 feet.

Gage at time of survey was 13.0 feet or 17.0 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PETERS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 13, 1908.

EIGHT DAYS AFTER DREDGING SECOND TIME.

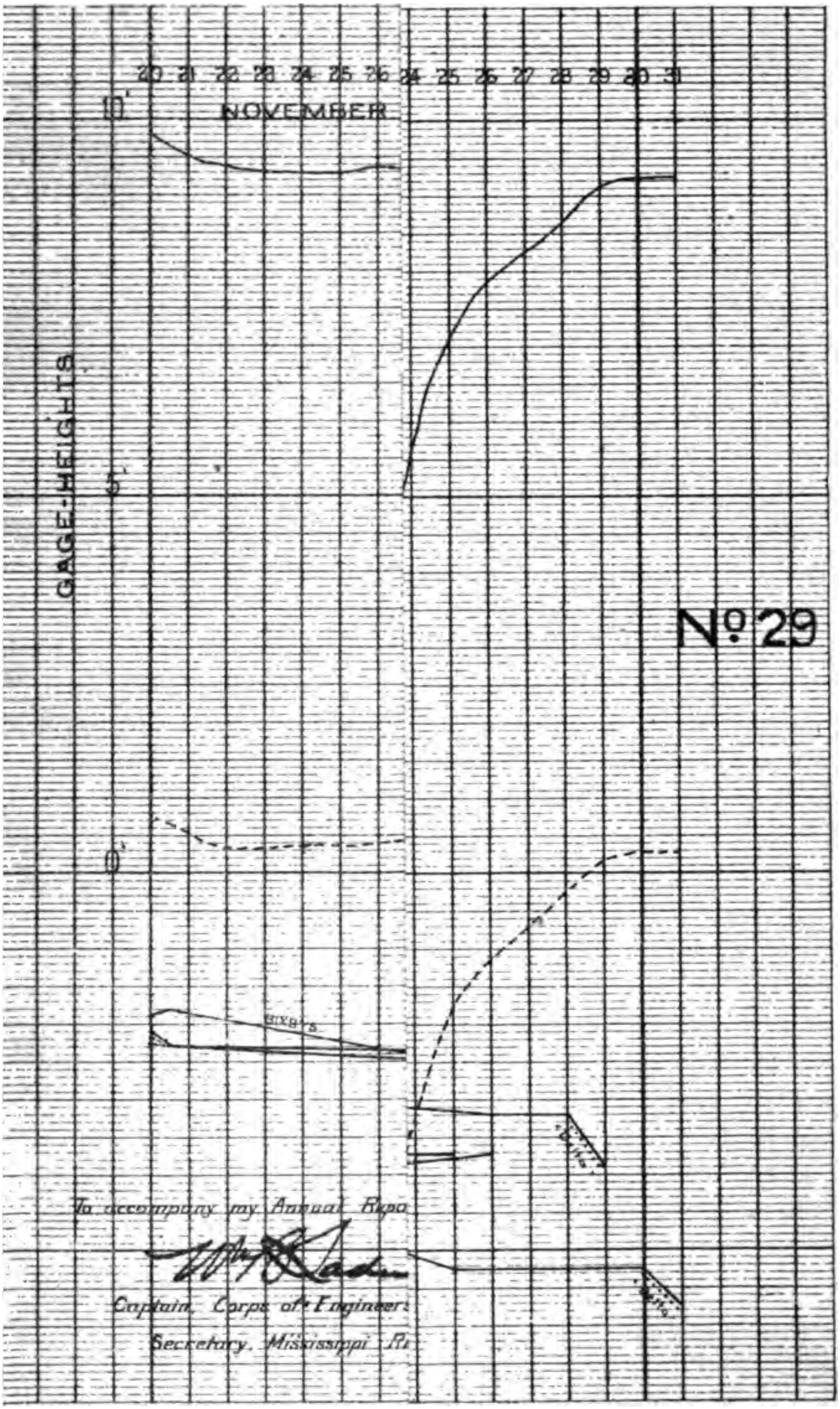
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Mhoons Landing gage, which corresponds to a reading of —4.0 feet.

Gage at time of survey was 11.5 feet or 15.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

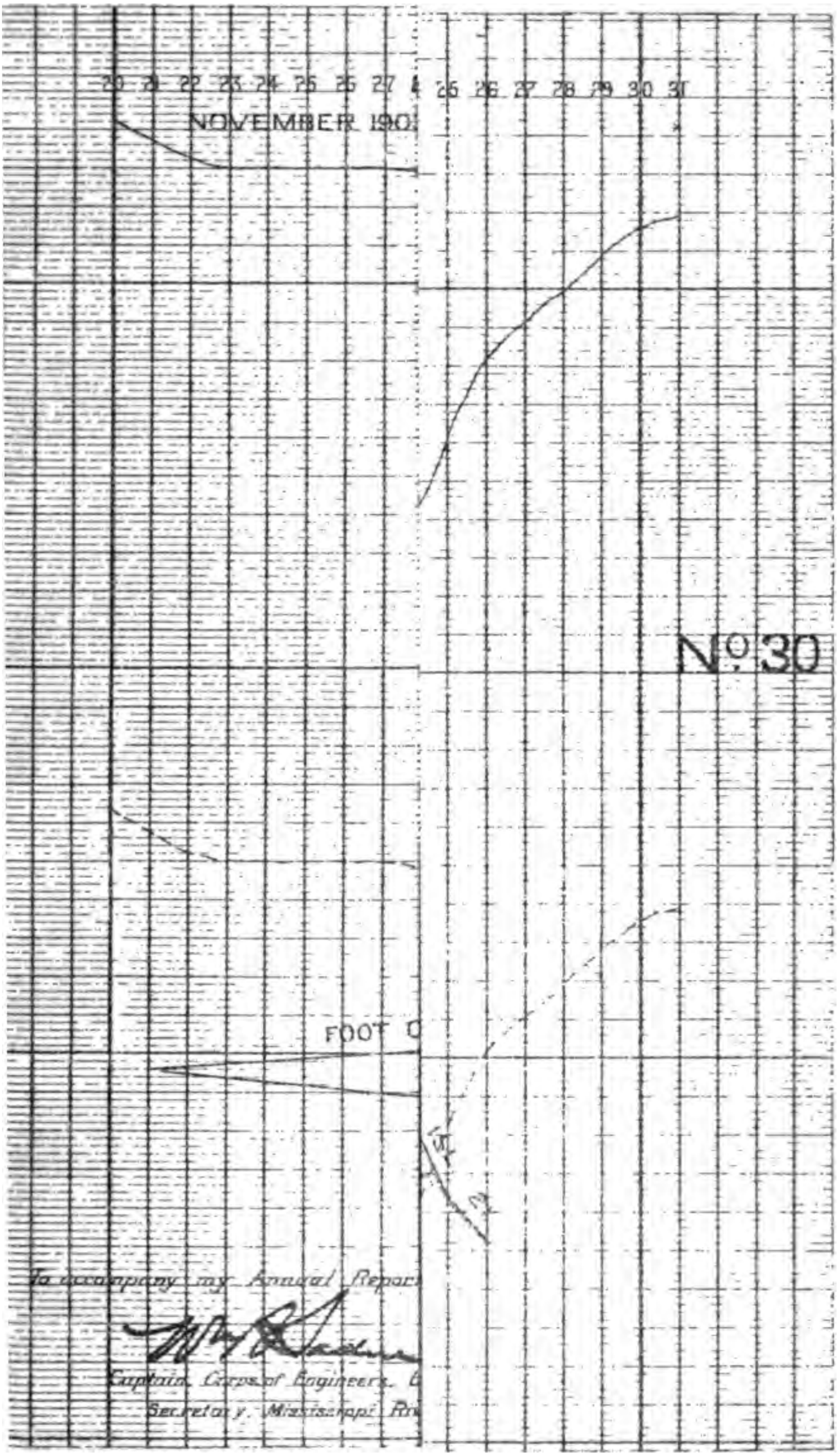


Nº 29

To accompany my Annual Repo

Captain, Corps of Engineers

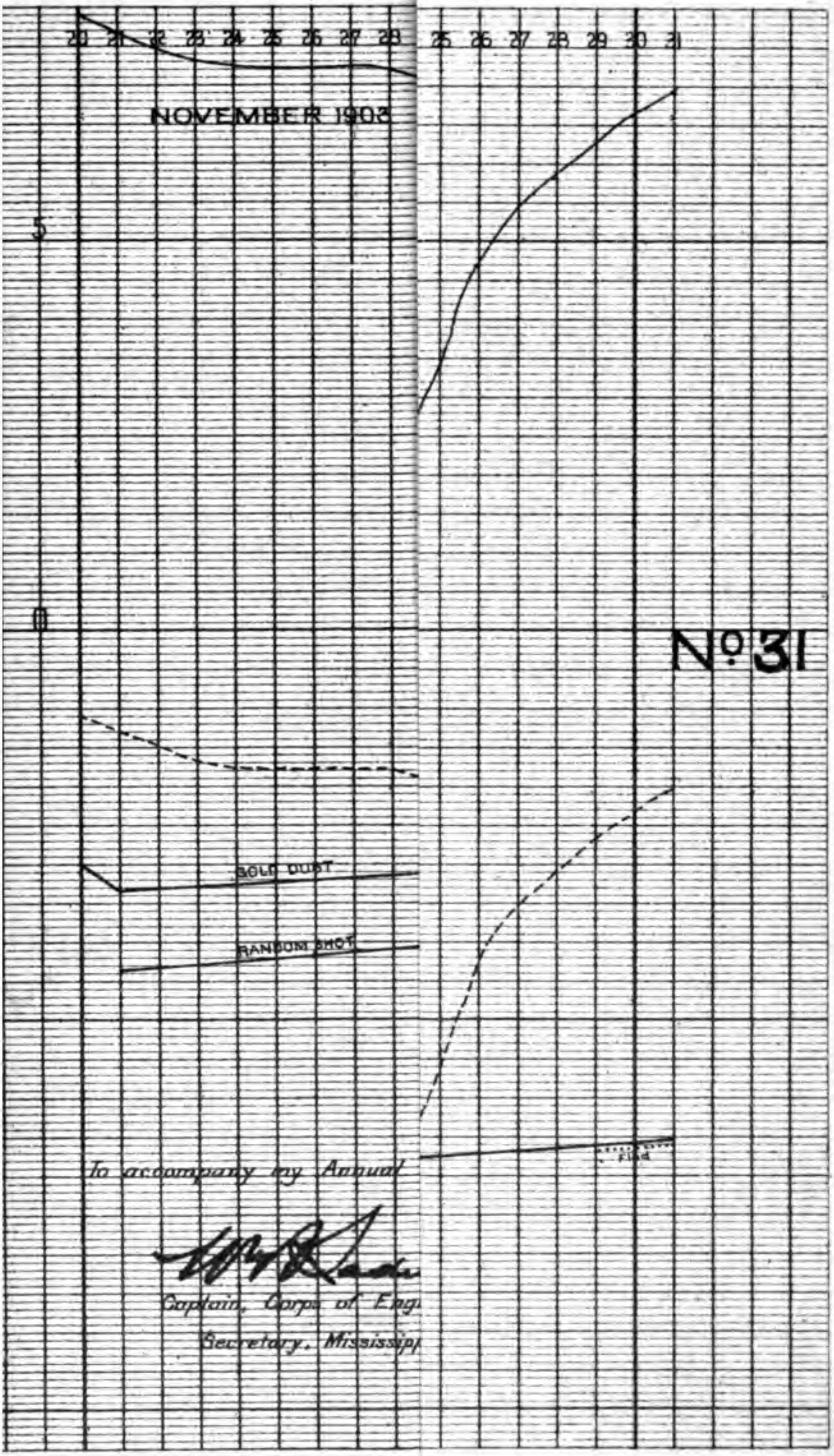
Secretary, Mississippi Ri



Nº 30

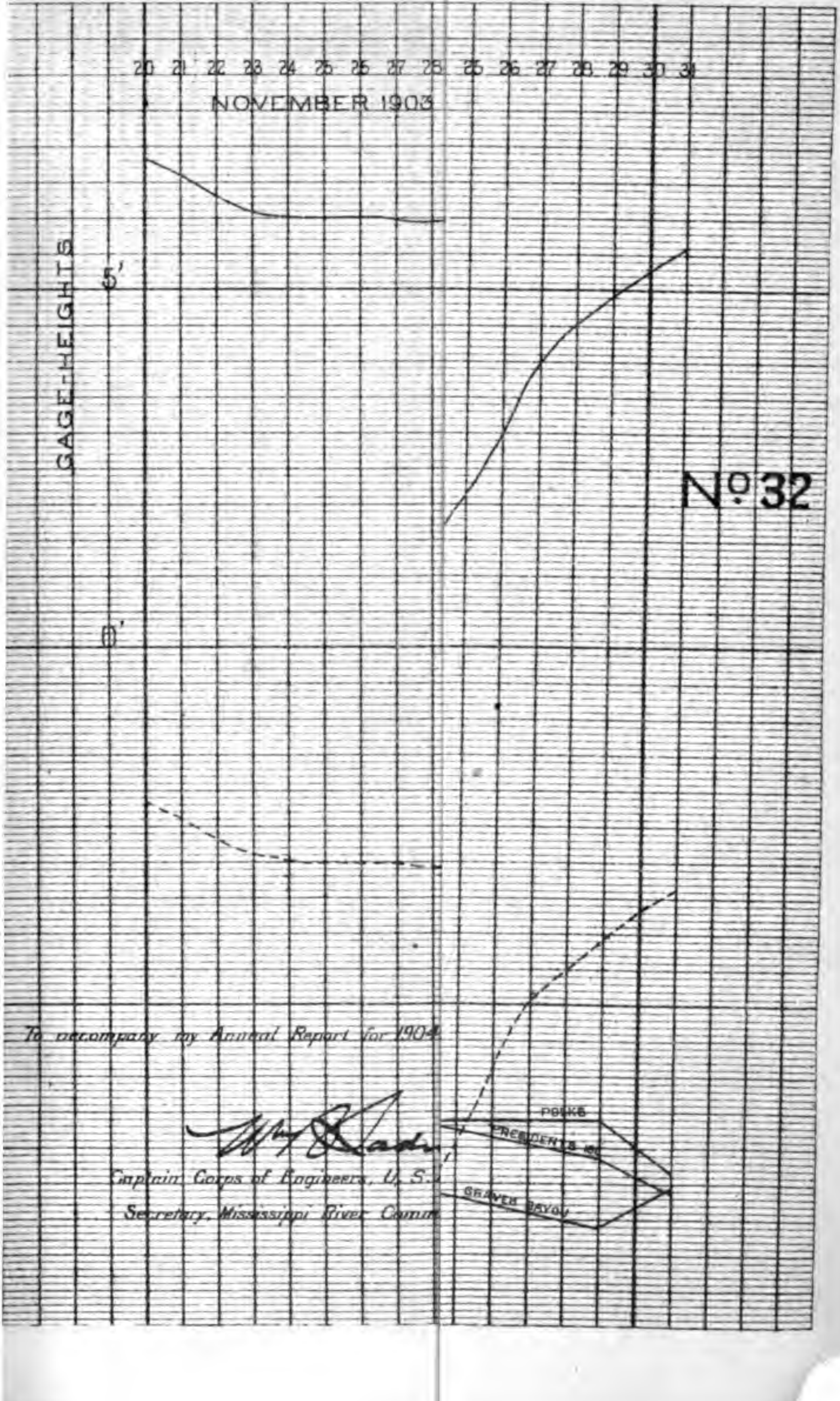
To accompany my Annual Report

Captain, Corps of Engineers, C
Secretary, Mississippi Riv


20 21 22 23 24 25 26 27 28
25 26 27 28 29 30 31
NOVEMBER 1903
5
0
GOLD DUST
RANSOM SHOT
Flad
To accompany my Annual
Captain, Corps of Engi
Secretary, Mississipp

Nº 31

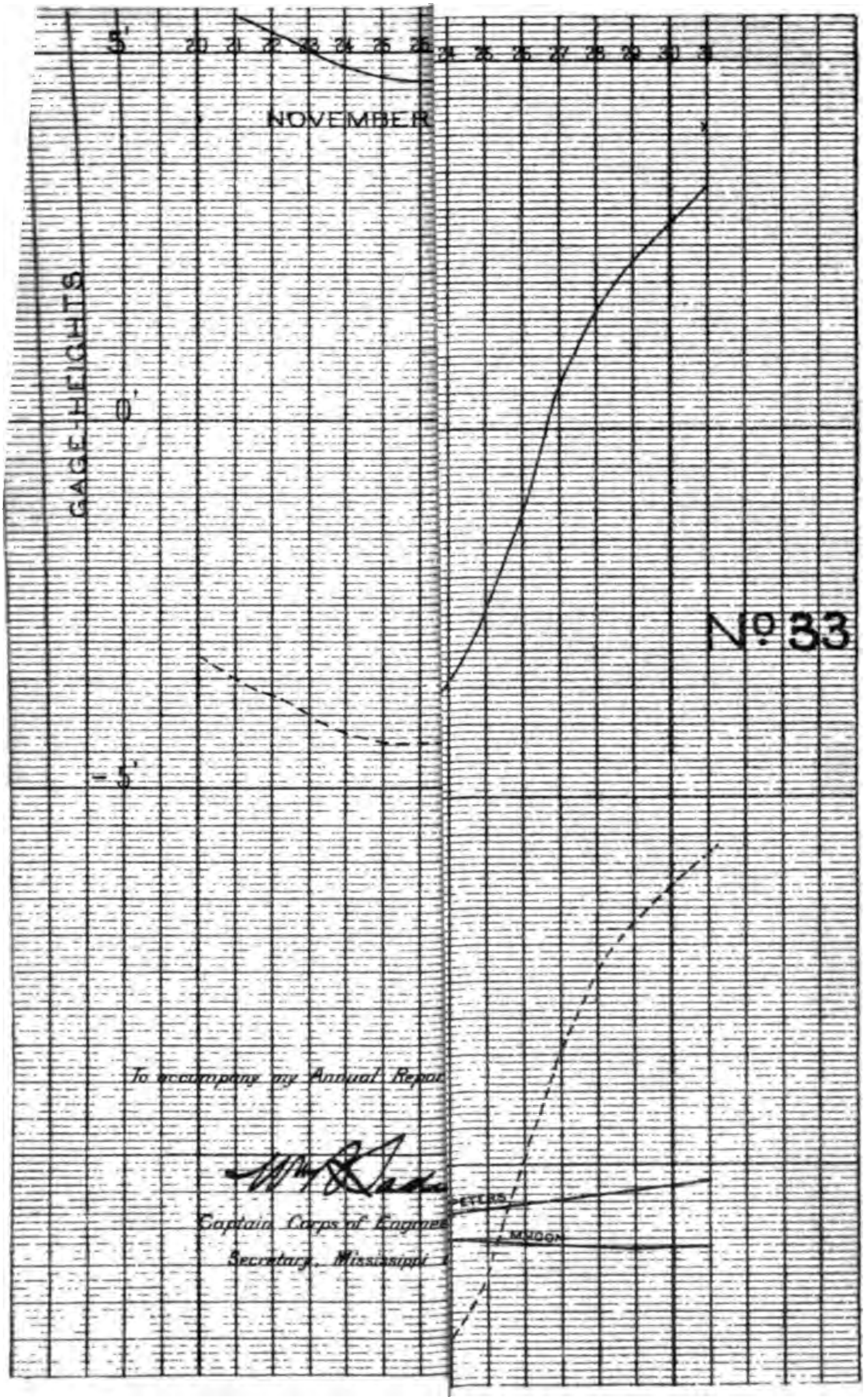
Nº 32



To accompany my Annual Report for 1904.

Captain Corps of Engineers, U. S.

Secretary, Mississippi River Comm



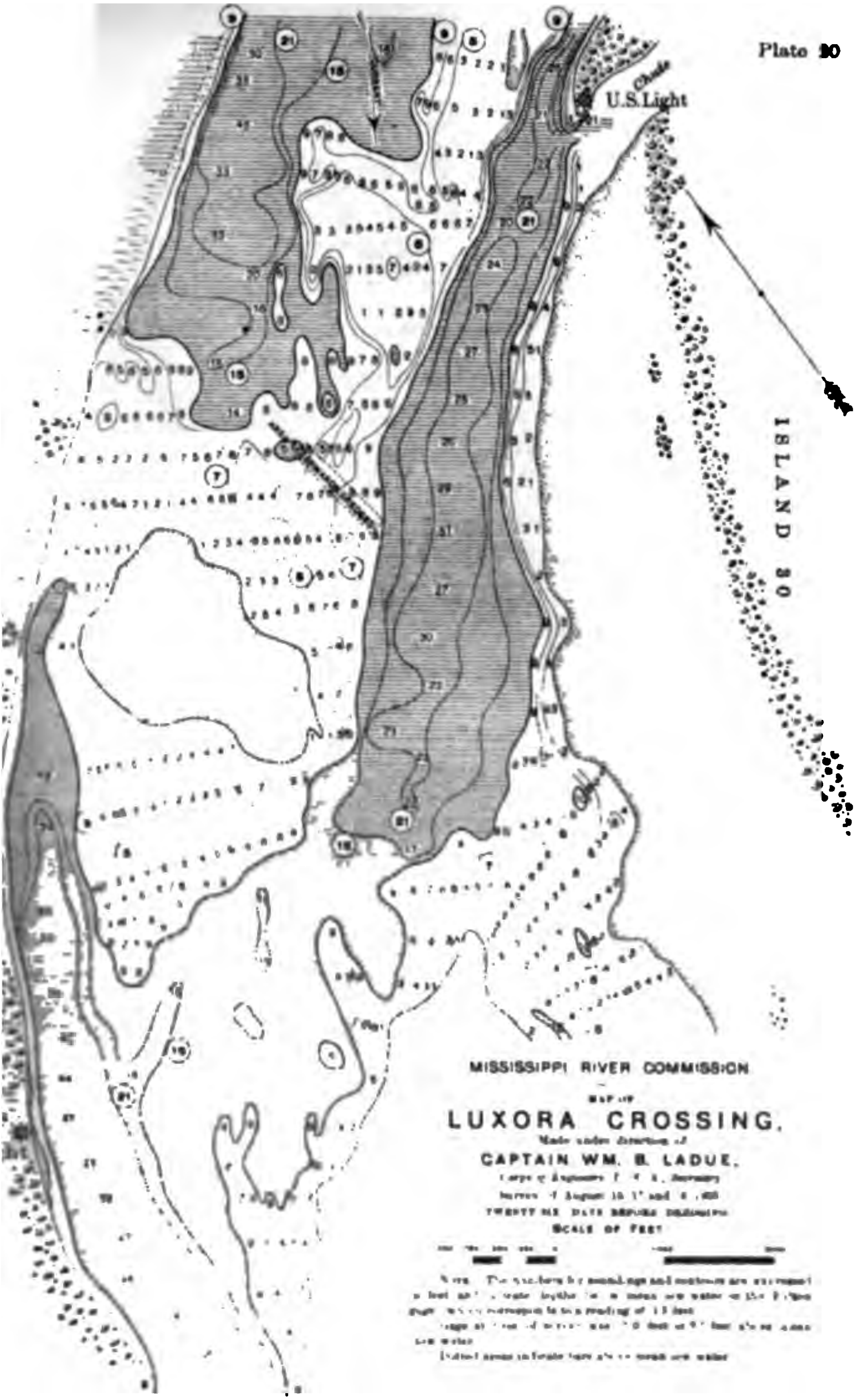
Nº 33

To accompany my Annual Repor

Captain Corps of Enginee

Secretary, Mississippi

Plate 30



MISSISSIPPI RIVER COMMISSION

MAP OF

LUXORA CROSSING.

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers U. S. A., Secretary

Survey of August [illegible]

TWENTY SIX DAYS BEFORE DREDGING

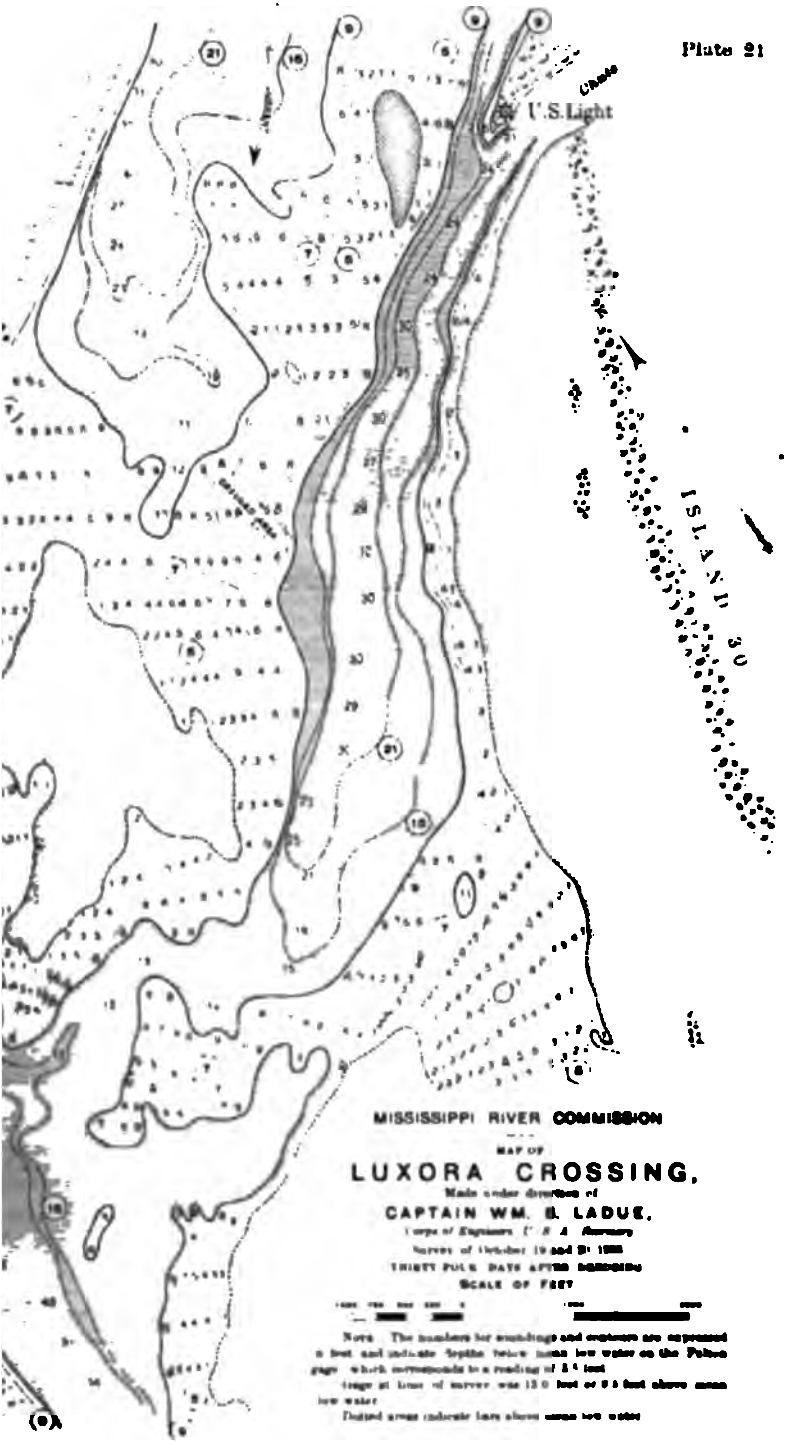
SCALE OF FEET

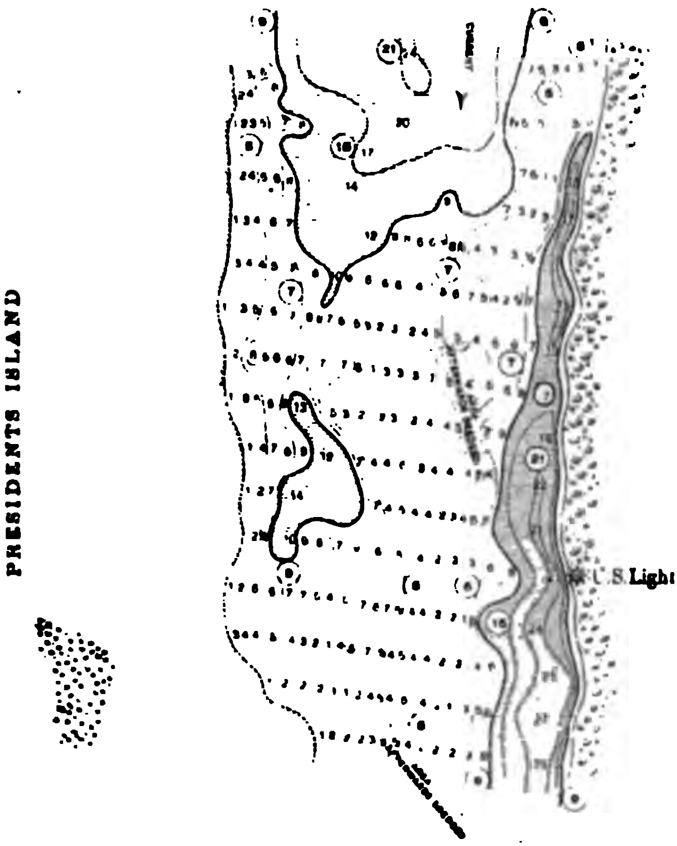
Note. [illegible] 13 feet.

[illegible]

[illegible]

Plate 21


Chute
U.S.Light
ISLAND 30
MISSISSIPPI RIVER COMMISSION
MAP OF
LUXORA CROSSING,
Made under direction of
CAPTAIN WM. L. LADUE,
Corps of Engineers, U. S. A., Secretary
Survey of October 19 and 21 [illegible]
THIRTY FOUR DAYS AFTER DREDGING
SCALE OF FEET
Note. The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of [illegible] feet.
Gage at time of survey was 12.0 feet or [illegible] feet above mean low water.
Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. L. LADUE,

Corps of Engineers U. S. A., Secretary

Survey of September 10 and 11 [illegible]

TWENTY EIGHT DAYS BEFORE DREDGING FIRST TIME

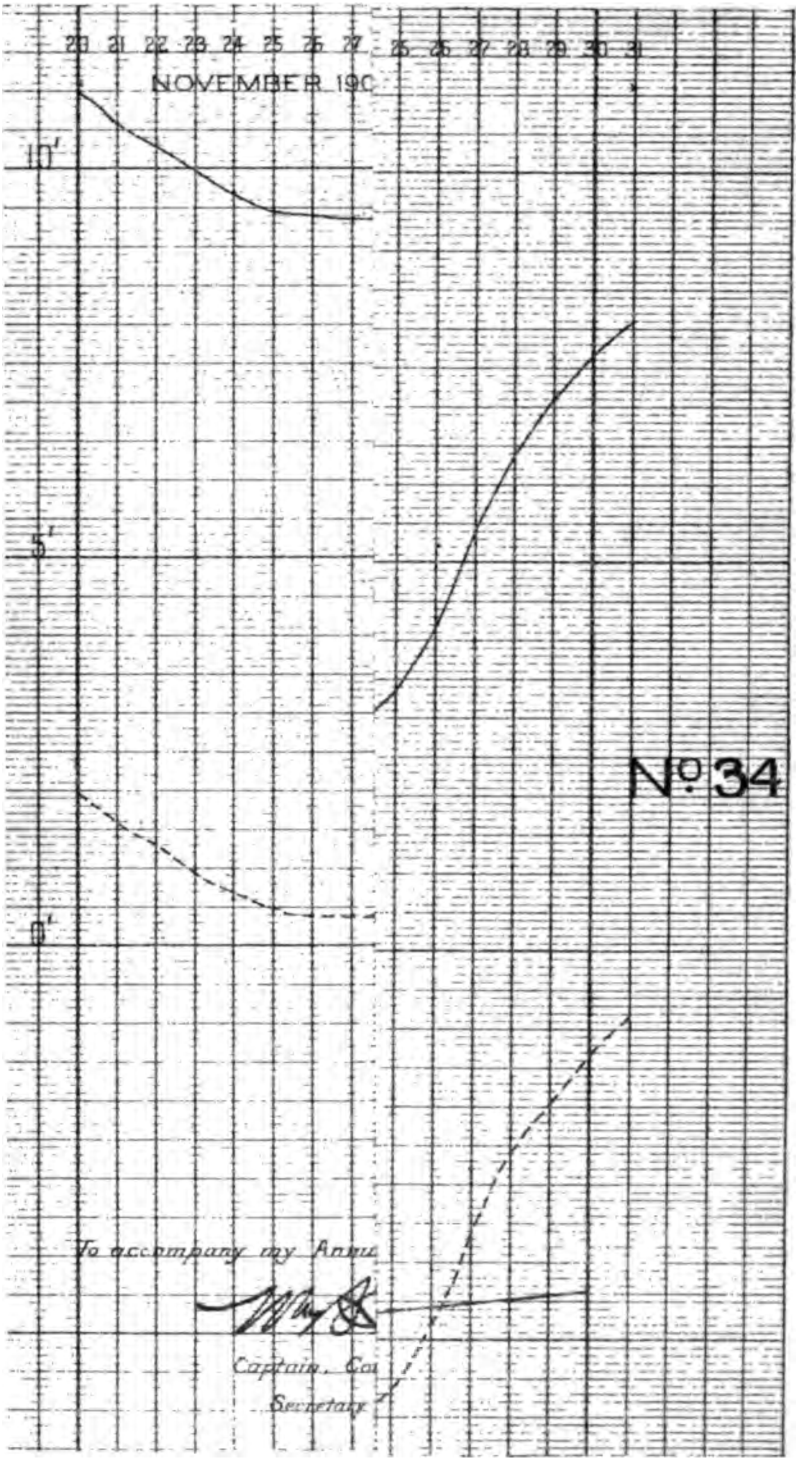
SCALE OF FEET

[illegible] 0 1000 [illegible]

Note - The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of [illegible] feet

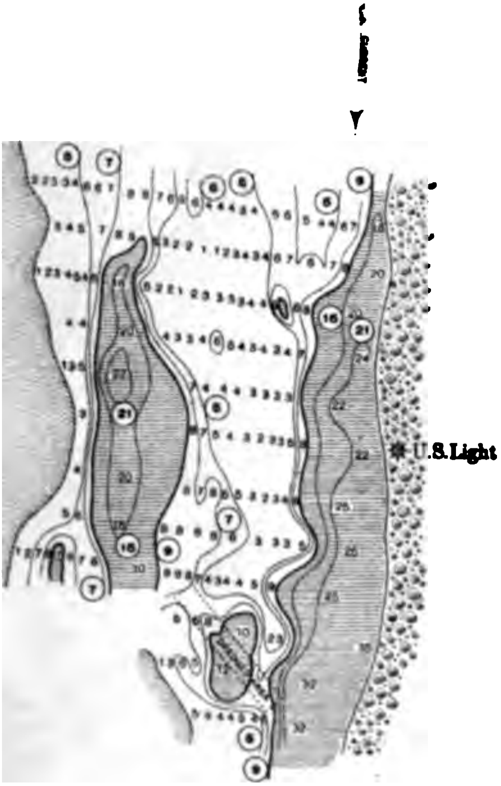
Gage at time of survey was 11.3 feet or [illegible] feet above mean low water

Dotted areas indicate bars above mean low water


20 21 22 23 24 25 26 27
25 26 27 28 29 30 31
NOVEMBER 190
10'
5'
0'
To accompany my Annu
Captain, Co
Secretary

Nº 34

Plate 24



MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. E. LADUE,

Corps of Engineers, U. S. A., Secretary

Survey of November 18 [illegible]

ONE DAY AFTER DREDGING SECOND TIME

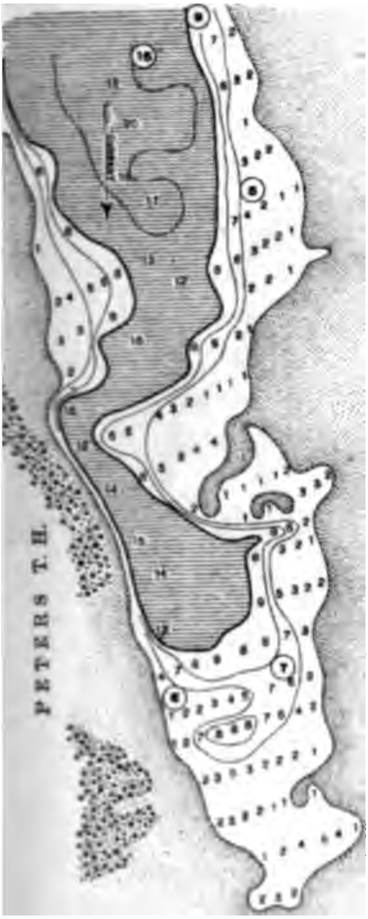
SCALE OF FEET

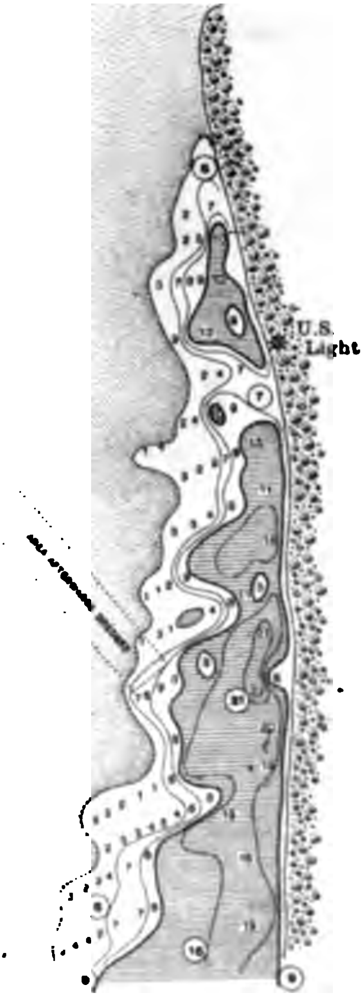
Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of [illegible] feet.

Gage at time of survey was [illegible] feet or [illegible] feet above mean low water.

Dotted areas indicate bars above mean low water.

Plate 25





MISSISSIPPI RIVER COMMISSION.

MAP OF

PETERS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary

Survey of August [illegible] and [illegible], [illegible]

TWO DAYS BEFORE DREDGING FIRST TIME

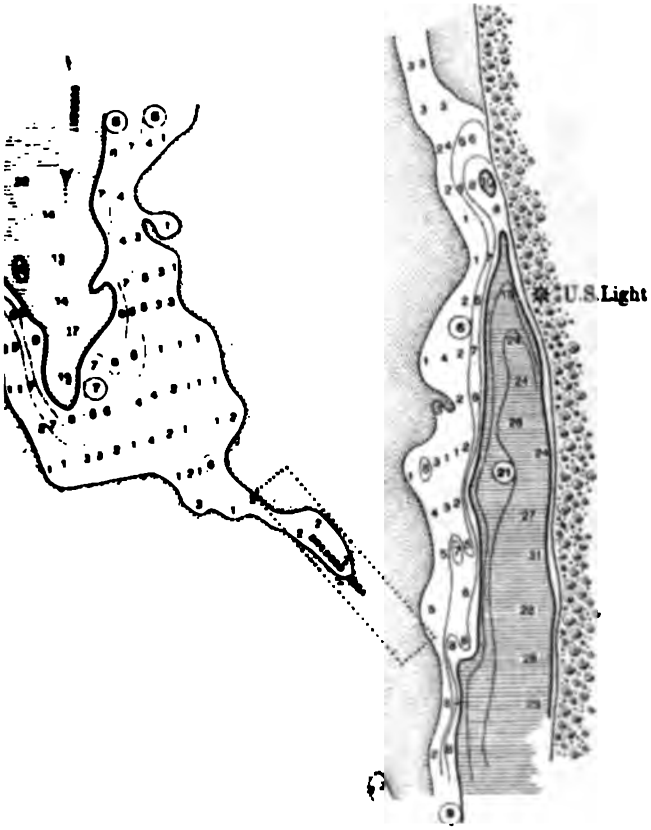
SCALE OF FEET

[illegible]

Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gauge, which corresponds to a reading of 4.0 feet. Gauge at time of survey was [illegible] feet or [illegible] feet above mean low water.

Hatched areas indicate bars above mean low water.

Plate 27



MISSISSIPPI RIVER COMMISSION.

MAP OF

PETERS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers U. S. A., Secretary

Survey of September [illegible]

TWO DAYS BEFORE DREDGING [illegible]

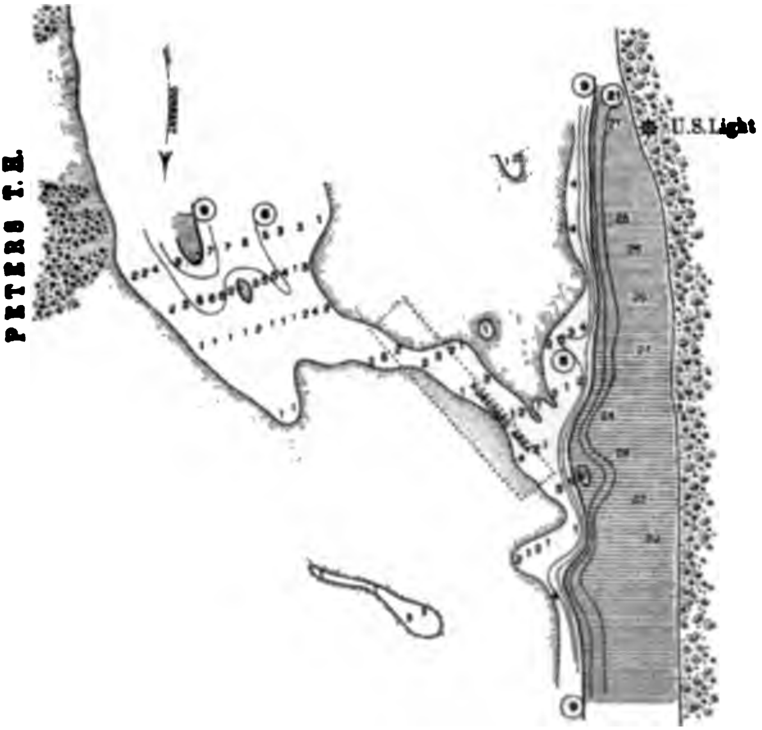
SCALE OF FEET

Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the [illegible] Landing gage, which corresponds to a reading of -4.0 feet.

Gage at time of survey was 13.0 feet or 17.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Plate 28



MISSISSIPPI RIVER COMMISSION.

MAP OF

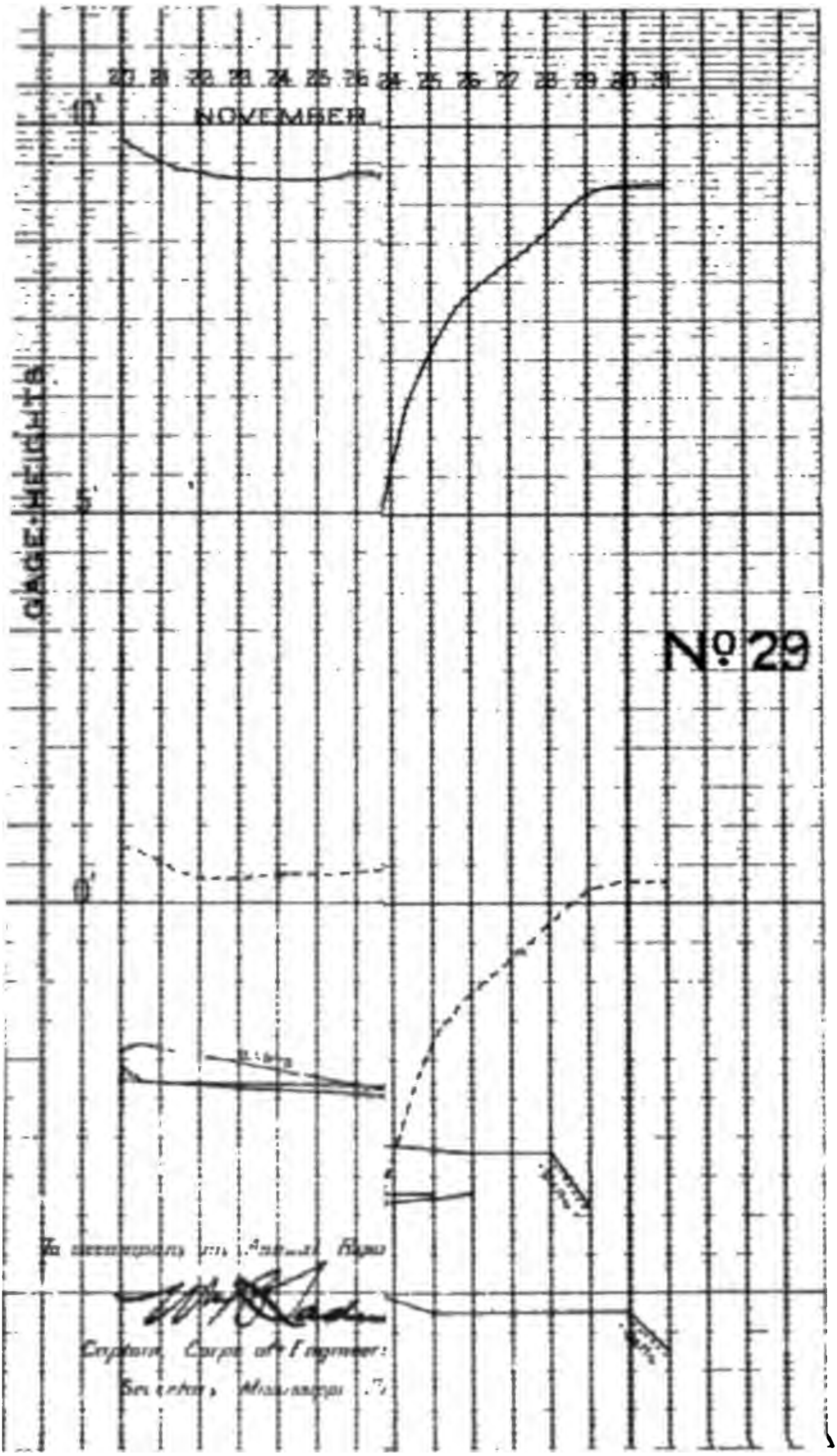
PETERS CROSSING,
Made under direction of
CAPTAIN WM. B. LADUE,
Corps of Engineers, U. S. A., Secretary.
Survey of October 13, [illegible]
EIGHT DAYS AFTER DREDGING CEASED THERE.
SCALE OF FEET

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the [illegible] Landing gage, which corresponds to a reading of −4.0 feet.

Gage at time of survey was 11.5 feet or 15.5 feet above mean low water.

Dotted areas indicate bars above mean low water.



No. 29

To accompany my Annual Report

Captain, Corps of Engineers

Secretary, Mississippi [illegible]

6 steel drills for boiler ratchet, ⅜ to 1 inch, advancing by eighths.
2 melting ladles, medium and small.
1 pipe vise, hinged to take pipe up to 3 inches.
2 pipe cutters, "Barnes" three wheel Nos. 1 and 2.
6 pipe tongs, "Brown's adjustable" Nos. 1 to 5.
3 chain pipe wrenches, "Brock's" Nos. 2, 3, and 4.
8 "Stillson's" wrenches, two each 6, 10, 14, and 24 inches.
12 engineer's wrenches, "Buck's," wrought bar and well casehardened, two each 6 and 8 inches, three each 10 and 12 inches, one each 15 and 18 inches.
1 set of drop forged steel wrenches for each engine, machine, and pump.
1 set of drop forged steel wrenches for each capstan engine.
2 brass oiler sets, 6 pieces each.
6 oilers, steel, assorted ¼ to 1 pint.
6 oilers, long spout, 1 pint.
6 oilers, long spout, 1 quart.
4 filling cans, two 1 quart, two 2 quart.
3 galvanized iron oil tanks, 55 gallons, with pumps, measures, and funnels complete.
1 set of firing tools for each battery of boilers.
12 short-handled coal shovels.
2 long-handled coal shovels.

WM. B. LADUE,
Captain, Corps of Engineers,
Secretary Mississippi River Commission.

OFFICE OF THE SECRETARY,
MISSISSIPPI RIVER COMMISSION,
St. Louis, Mo., May 17, 1904.

APPENDIX 2.

REPORT OF CAPT. E. W. VAN C. LUCAS, CORPS OF ENGINEERS, ON OPERATIONS IN THE FIRST, SECOND, AND THIRD DISTRICTS.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., June 1, 1904.

COLONEL: I have the honor to submit the following report of operations in the first, second, and third districts, Mississippi River improvement, for the year ending May 31, 1904.

The first district extends from Cairo, Ill., to the foot of Island No. 40, a distance of 220 miles. Operations in this district include bank revetment work at Columbus and Hickman, Ky., and at New Madrid and Caruthersville, Mo.; systematic improvement of Plum Point Reach, Tennessee and Arkansas; abatis dike work; upper St. Francis and Reelfoot levee districts, and lower St. Francis levee district to the one hundred and thirty-ninth milepost.

The second district extends from the foot of Island 40 to the mouth of White River (393 R.), a distance of 173 miles, excepting on the left bank, where it ends at the Coahoma-Bolivar County line (365 L.). Operations in this district include bank revetment work at Memphis, Tenn., and Hopefield Bend and Helena, Ark.; the improvement of Wolf River, Tennessee; the White River and upper Yazoo levee districts, and the lower part of the lower St. Francis levee district.

The third district extends from the Coahoma-Bolivar County line on the left bank (365 L.) and the mouth of White River on the right bank (393 R.) to the latitude of Warrenton, Miss. (607 L.). Its operations include bank-revetment work at Lake Bolivar front, Ashbrook Neck, and Greenville Harbor, Mississippi, and Lake Providence and Delta Point, Louisiana, the abandoned work of systematic improvement of Lake Providence Reach, and the Lower Yazoo and Upper Tensas levee districts.

PART I.—CHANNEL WORK.

FIRST DISTRICT (CAIRO TO FOOT OF ISLAND 40, 220 MILES).

Columbus, Ky. (21 L.).—(For description and previous history see p. 3580, Report Chief of Engineers, 1891.) Special appropriation. This work (see map No. 1 herewith) consists of a series of five spur dikes protecting about 2,200 feet of bank in front of the town. No work has been done since 1890, and the present conditions are fairly good and as stated in the last annual report.

Hickman, Ky. ([illegible] L.). For description and previous history see Reports Chief of Engineers, 1890, p. 3197; 1895, p. 3756; 1902, Supplement, p. 91. Special appropriation. This revetment (see map No. 2 herewith) was placed in 1889, 1892, and 1894 and includes 1,450 feet of effective revetment, of which 800 feet is old-style woven mattress and 650 feet fascine mattress. The work is in satisfactory condition.

New Madrid, Mo. ([illegible] R.). For description and previous history see Reports Chief of Engineers, 1894, p. 2859; 1895, p. 3757; 1897, p. 3686; 1899, p. 3501; 1900, p. 4784. Special appropriation. This work (see map No. 3 herewith) consists of 1,450 feet of effective revetment, all of fascine mattress, and is generally in good condition, excepting at a few places near the low-water line, where the brush is somewhat decayed. This will be repaired whenever the stage of water is sufficiently low. A recent change in the channel crossing just above the town threatens the upper end of the revetment work, which may have to be extended about 1,000 feet upstream. For this purpose $20,000 appropriated in the river and harbor act of 1902 will be available during the next two years.

Caruthersville, Mo. ([illegible] R.). For description and previous history see Reports Chief of Engineers, 1899, p. 3501; 1900, p. 4784; and 1903, Supplement, p. [illegible]. Special appropriation. This work (see map No. 4 herewith) consists of four dikes and about 2,300 feet of effective revetment, all of fascine mattress. This revetment is in good condition with the exception of some scalping of the bank above the pavement which occurred during the overflow of April, 1904. The heavy caving immediately below the revetment continued until October last, but since then the bank has been nearly stationary. The lower end of the revetment is likely to be destroyed, however, by caving due to eddy action at its foot, and there are some signs of bank caving above the revetment which may make necessary an upstream extension about 1,000 feet long. No funds are available for further work here.

Plum Point Reach, Tenn. ([illegible]). See map No. 5 herewith. The works of improvement in this reach extend from above Daniels Point to near Craighead Point, Arkansas, a distance of about 20 miles (151–171). These operations were begun in 1882 and have been fully described in subsequent reports. In general terms the work done has been the closure of Osceola and Bullerton chutes by pile dikes; the partial closure of Gold Dust Chute by pile dikes and a brush and stone dam; the contraction of the low-water channel by dikes at Ashport bar, Elmot bar, and Plum Point; the revetment of caving banks above Daniels Point, throughout Ashport and Fletchers Bend, along a part of the fronts of Osceola and Bullerton bars, at Plum Point and near Craighead Point; and the construction of levees along both banks of the river. From funds appropriated by the sundry civil bill of March 3, 1903, the Commission allotted $40,000, as follows:

Daniels Point	$10,000
Ashport Bend	8,000
Fletchers Bend	17,000
Osceola bar	5,000
	40,000

With the subsidence of the June rise it was found that serious damage had been done by the overflows of 1903 to the old woven mattress revetment [illegible] Bend, and the $5,000 allotted to Osceola bar was transferred to that [illegible] which was considered the most important in the reach.

Daniels Point, Tenn. ([illegible] R.). For description and previous history see Reports of Chief of Engineers, 1903, Supplement, p. 170. See map No. [illegible]. [illegible] recently this revetment extended about 8,800 feet upstream from Daniels Point, [illegible] during the past two years the lower 1,000 feet has been practically [illegible] few detached pieces of revetment remaining. Operations during the past year were carried on under an allotment of $10,000 from the appropriation of March 3, 1903, and consisted of minor repair work. [illegible] were placed, [illegible] linear feet of bank graded, [illegible] near the foot of the 18[illegible] revetment.

The cost of the season's work was $[illegible]

Asst. Engineer A. J. N[illegible], Assistant [illegible]

At present the effective continuous revetment [illegible] 4,800 feet [illegible] of fascine mattress and the [illegible] mattress was continued. About 2,000 feet [illegible] mattresses.

The caving below the upper work appears to have ceased, and there is no apparent necessity for replacing it. No operations are contemplated for the coming season.

Ashport Bend, Tenn. (155 L.).—(For description and previous history see Reports Chief of Engineers, 1900, p. 4785; 1903, Supplement, p. 170.) This bend (see map No. 7 herewith) has a continuous revetment about 16,450 feet long, of which about 7,500 feet at the lower end is of fascine mattresses, and the remainder of woven mattresses. It is all in effective condition. Work was carried on during the past season under an allotment of $8,000 from the appropriation of March 3, 1903, and consisted in completing the repair work, started during the previous season, by placing a pocket mat 111 by 120 feet. After the subsidence of the 1903 flood the bank for a considerable distance was found to be scalped from the top of the pavement for some distance back, and in places the bank behind the paving had been scoured away. To prevent further erosion of this description 10 crib dikes were constructed from the upper edge of the paving to the crest of the bank, and willows were planted at 15-foot intervals for the purpose of inducing a natural growth. The total cost of the season's work was $5,428.99. (For further details see report of Asst. Engineer A. J. Nolty, Appendix 2 A, herewith.)

Fletchers Bend, Ark. (158-161 R.).—(For description and previous history see Reports of Chief of Engineers, 1900, p. 4786; 1903, Supplement, p. 170.) Until recently this revetment (see map No. 8 herewith) was 17,300 feet long, but during the last two years about 4,400 feet of woven mattress revetment built in 1884-1891 has been destroyed, while about 2,000 feet of fascine mattress revetment has been built to partially replace it.

Operations during the season were carried on under allotments of $15,000 from the appropriation of March 3, 1903, and of $36,000 from the same appropriation, originally allotted to Osceola bar and later transferred to this work. Two fascine mattresses were sunk—one, 705 feet long, just above, and one, 778 feet long, just below the 1902 work. A pocket cave at the shore edge of the 1899 revetment, near the head of the work, was repaired with fascine pocket mattresses. The total cost of the season's work was $41,216.28. The cost per linear foot of new revetment was $27.79. (For further details see report of Asst. Engineer A. J. Nolty, Appendix 2 A, herewith.)

The programme of work during last season was carried out successfully and without incident as far as practicable with available funds. At the end of the 1902-3 season 10,068 cubic yards of stone were left stored on the revetted bank, which afterwards gave way, and out of the lot only 2,137 cubic yards were recovered, the net loss being 7,931 cubic yards. Much difficulty was experienced throughout the working season in obtaining a sufficient supply of stone, and for this reason the cost of the work was somewhat increased. The present effective revetment has a total length of 14,900 feet, of which 7,550 feet consists of groins, dikes, and woven mattresses, and 7,400 feet of fascine mattresses. Below the 1903 work is a gap 2,500 feet long, where the old woven mattresses have been destroyed and which it is intended to replace with new revetment during the coming season. For about 2,800 feet below this gap the revetment consists of old woven mattresses built in 1891, which are beginning to show signs of weakness. This will be reinforced with fascine mattresses as far as practicable with available funds, as by doing the work before the old revetment is destroyed the bank paving is saved and the cost reduced about half.

Osceola bar (163 R.).—(For description and previous history see Reports of Chief of Engineers, 1896, p. 3600; 1903, Supplement, p. 170.) This revetment (see map No. 9 herewith) was until recently about 7,700 feet long and consisted of 3,750 feet of fascine mattress revetment, below which was about 4,000 feet of woven mattress revetment. About two years ago this revetment was attacked at its head, and since that time almost the entire fascine mattress revetment has been destroyed. The present effective revetment consists of about 300 feet of fascine mattress revetment and about 4,000 feet of woven mattress work. This woven mattress revetment, while still in place, is not subject to current attack, being below the projecting point at the foot of the fascine revetment. Should the point be carried away the woven mattress revetment would be rapidly destroyed and the caving would continue downstream and destroy the Lower Osceola and Bullerton revetments.

No work was done here during the year, although a new fascine mattress revetment to replace the lost work was contemplated, and an allotment for that purpose of $36,000 was made from the appropriation of March 3, 1903. This allotment was later transferred to the Fletchers Bend work on account of the greater necessity at the latter place. During the year the destruction of the 1895 fascine mattress revetment has continued, but at a reduced rate.

About 2,000 feet of new revetment is needed at the head of this work for its proper protection. This should by all means be done, if possible, during the coming season, as the present bank line is unusually good.

Lower Osceola and Bullerton bars, Ark. (165-168 R.).—The revetment at this place (see map No. 10 herewith), 14,300 feet long, is all effective, and consists of 3,100 feet of woven mattress revetment and 11,200 feet of fascine mattress revetment. The fascine revetment on Bullerton bar is notable as being the first extensive fascine mattress work done on the Mississippi River. It was placed in 1893-94, is in excellent condition, and has cost absolutely nothing for maintenance or repairs.

Abattis dikes.—No allotment was made for the construction of abattis dikes during the past season, but an examination of the dike at Island 14 (183 R.) (see map No. 11 herewith), placed during the season of 1902-3, disclosed a gap about 200 feet wide, where a section had been torn away during the 1903 overflow. This was replaced in January, at a cost of $1,131.83, funds being available from a small balance from the previous season's work. (For further details see report of Asst. Engineer A. J. Nolty, Appendix 2 A, herewith.)

SECOND DISTRICT (FOOT OF ISLAND 40 TO WHITE RIVER, 173 MILES).

Hopefield Bend, Ark. (227-230 R.).—(For description and previous history see Reports of Chief of Engineers, 1900, p. 1787; 1903, Supplement, p. 172.) The revetment at this place (see maps Nos. 12 and 13 herewith), originally extending a distance of 16,000 feet from Mound City Chute to Hopefield Bend, is essential to the maintenance of deep water in Memphis Harbor. From station 0 upstream to Mound City Chute, a distance of 6,300 feet, the revetment was of light woven mattresses built in 1883-1885, and is either destroyed or so weak as to be entirely useless. From station 0 downstream, a distance of 4,000 feet, the revetment is of diagonal woven mattresses built between 1887 and 1892, and has failed in places, and shows signs of general weakness. Below this the revetment consists of 6,300 feet of fascine mattresses, which, when the bank was last exposed, was in thoroughly good condition.

Work during the season was carried on with an allotment of $90,000 from the appropriation of March 3, 1903, and consisted of about 2,600 feet of new fascine mattress revetment extending upstream from a point about 1,300 feet above station 0, and replacing a part of the destroyed woven mattresses built in 1883-84. In addition, a connecting mat 810 feet long and 116 feet wide was placed downstream, from a point 400 feet below station 0, to repair breaks in the 1891 revetment. There were also placed 18 connecting mats, this large number being rendered necessary by the continuous caving during the progress of the work, which made the bank line extremely ragged.

The work done this season was carried on under great difficulties on account of the constantly caving bank and the strong current, ranging from 6 to 8 feet per second. Channel mats Nos. 1 and 2, respectively 1,000 feet and 1,150 feet long, and 254 feet wide, were successfully sunk, with current velocities between 6 and 8 feet per second. Channel mat No. 3, 915 by 254 feet, built with especial care, and sunk in a current of 6 feet or less per second, was broken in sinking and the lower 765 feet lost. The cause of this loss is difficult to determine, but it was doubtless due to the following combination of adverse circumstances: While the mattress was being constructed a raft of 40 (estimated) saw logs was forced under the head barges and lodged under and about 200 feet below the head of the mattress. While the head of the mattress was being lowered, the towboat [illegible] was blown onto it and hauled off after an hour's work. This dragging over the mat caused some damage, and probably weakened the outer edge at the place where the rupture afterwards started. After the boat was released and the head of the mat successfully sunk, and [illegible] the entire mat below the surface, a large cave occurred just abreast of the [illegible] rupture, and the weight of falling earth, estimated at several thousand [illegible] inner part of the mat, forced it away from the bank, and caused [illegible] strains on the outer edge. At about the same time a number of the saw logs [illegible] ously lodged under the mat were forced through and appeared [illegible]. The rupture of the mat started at the outer edge, the mat was torn [illegible] the bank, and the lower part drifted downstream, was guided by the towboat [illegible] bridge, and lodged on the head of Presidents Island. The value of [illegible] $11,[illegible].42.

The remaining channel work of the season, of a minor character, was [illegible] successfully and without incident. The bank was graded [illegible] 2½ to 1 on 3, the slope being carried to within 6 feet of the [illegible]. The paving was of the standard type adopted in the first and second [illegible] consisted of a closely pitched layer of stone 7 to 8 inches thick [illegible] 3 to 4 inches thick. The paving was carried to stages varying [illegible] the Memphis gauge, the particular height being governed [illegible] and the paving being carried above all sandy strata to the [illegible] the bank.

the after bulkhead, with "U. S. Dredge" above and on each wheelhouse, as may be directed. The numbers of the staterooms will be painted on the inside doors as directed. All boats, fire pails, floats, life buoys, and other properties will have the name of dredge painted on them, as required by law.

242. Materials.—All coats of paint herein specified are to be counted, exclusive of the priming or filling coats. The materials used for the painting above specified shall be of the following kinds, grades, or qualities: White lead, to be strictly pure, ground in bleached linseed oil, "Collier," "Southern," or equal; white zinc, to be best quality Green Seal French Process Zinc, manufactured by John W. Masury & Son; colors, to be the pure colors, ground in oil, manufactured by John W. Masury & Son; lampblack, to be Eddy's, in papers; linseed oil, to be strictly pure, will be tested before it is permitted to be used; turpentine, to be strictly pure and clear; spar varnish, to be Berry Brothers' Elastic Spar Varnish, for outside work; dammar varnish, to be Berry Brothers' Crystal Grinding Damar; inside coach varnish, to be Berry Brothers' Inside Coach Finishing, for inside work; japan drier, to be Berry Brothers' Strictly Pure Turpentine Oil Japan; putty drier, to be strictly pure.

The varnishes and japan drier must be delivered in the manufacturers' original unbroken packages, bearing their cap, seal, and label, and must not be opened until inspected.

WORKSHOP AND MACHINE TOOLS.

243. Machine tools.—The machine shop will be outfitted with the following tools:

Engine, to be vertical, with 8-inch cylinder and 8 to 10 inch stroke, fitted and finished in the same manner as called for in the case of the larger engines.

Shafting, etc. A line of shafting with all requisite hangers, pulleys, and belts for driving all machines.

One 24-inch swing-screw cutting lathe with compound slide rest and rod feed; bed to be 14 feet long. The lathe to be furnished with a full set of change wheels, which must include those for cutting all pipe threads; also large and small face plates, 1 20-inch 4-jaw chuck, 1 9-inch 3-jaw chuck, steady and follow rests; the tail stock to have set-over for turning taper.

One 25-inch swing vertical drill press with back gear and power feed with quick return motion.

One 18-inch stroke crank shaper with swivel vise.

One "Peerless" No. 3 improved bolt and pipe threading machine, to cut bolts from ½ to 2 inches and pipes from ¼ to 3 inches, with a full set of both bolt and pipe dies and of machine taps from ½ to 2 inches; the fittings to include cutting-off knife, chuck for gripping nuts, and holder for taps; all threads to be United States standard.

One emery grinder with two wheels 12 by 12 inches and rests for tool grinding.

Two portable vise benches, 3½ feet long by 2½ feet wide, substantially made of hard wood, and fitted with 5½-inch machinist's parallel vises, Prentiss or equal.

One blacksmith's forge, 28 by 40 inches, with fan blower; to be set up and provided with hood smokestack made of No. 12 U. S. G. sheets, and all casings, deck rings, guys, etc.

All the above machine tools must be of first-class quality in every respect, of make approved by engineer officer in charge, and must be set up in location as may be directed and put in complete readiness for operation.

244. Small tools.—The following tools are to be supplied, of first-class quality throughout and of approved make:

One blacksmith's anvil, 200 pounds.

One sledgehammer, 12 pounds.

One sledgehammer, 6 pounds.

Two blacksmith's hand hammers, 2 pounds and 2 pounds 10 ounces.

Twelve blacksmith's tongs, assorted.

One set of blacksmith's tools, as follows: Top and bottom swages, ½, ¾, 1, 1½, 2, 2½, and 3 inches; top and bottom fullers ½, 1, and 2 inches; 1 flatter, 3 inches; 2 set-hammers, 1½ and 2 inches; 1 hot chisel, 2 inches; 2 cold chisels, 1½ inches; 6 punches, one each round and square, ½, ¾, and 1 inch; 1 set of heading tools for bolts, from ⅜ to 1 inch, advancing by eighths—heading tools for all special bolts about machinery, such as bolts for liners of pump, and for countersunk bolts in suction head.

One cast-iron swage block, medium size.

One 6-inch machinist's parallel vise, Prentiss or equal, for bench in machine shop.

One copper or rawhide hammer.

Three machinist's hand hammers, assorted.

Twelve machinist's hand chisels, assorted.

Two sleeve ratchets, 15 inches, Parker No. 6.

2 boiler ratchets, 12 inches, Parker No. 9.

6 steel drills for boiler ratchet, ⅜ to 1 inch, advancing by eighths.
2 melting ladles, medium and small.
1 pipe vise, hinged to take pipe up to 3 inches.
2 pipe cutters, "Barnes" three wheel Nos. 1 and 2.
6 pipe tongs, "Brown's adjustable" Nos. 1 to 5.
3 chain pipe wrenches, "Brock's" Nos. 2, 3, and 4.
8 "Stillson's" wrenches, two each 6, 10, 14, and 24 inches.
12 engineer's wrenches, "Buck's," wrought bar and well casehardened, two each 6 and 8 inches, three each 10 and 12 inches, one each 15 and 18 inches.
1 set of drop forged steel wrenches for each engine, machine, and pump.
1 set of drop forged steel wrenches for each capstan engine.
2 brass oiler sets, 6 pieces each.
6 oilers, steel, assorted ¼ to 1 pint.
6 oilers, long spout, 1 pint.
6 oilers, long spout, 1 quart.
4 filling cans, two 1 quart, two 2 quart.
3 galvanized iron oil tanks, 55 gallons, with pumps, measures, and funnels complete.
1 set of firing tools for each battery of boilers.
12 short-handled coal shovels.
2 long-handled coal shovels.

WM. B. LADUE,
Captain, Corps of Engineers,
Secretary Mississippi River Commission.

OFFICE OF THE SECRETARY,
MISSISSIPPI RIVER COMMISSION,
St. Louis, Mo., May 17, 1904.

APPENDIX 2.

REPORT OF CAPT. E. W. VAN C. LUCAS, CORPS OF ENGINEERS, ON OPERATIONS IN THE FIRST, SECOND, AND THIRD DISTRICTS.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., June 1, 1904.

COLONEL: I have the honor to submit the following report of operations in the first, second, and third districts, Mississippi River improvement, for the year ending May 31, 1904.

The first district extends from Cairo, Ill., to the foot of Island No. 40, a distance of 220 miles. Operations in this district include bank revetment work at Columbus and Hickman, Ky., and at New Madrid and Caruthersville, Mo.; systematic improvement of Plum Point Reach, Tennessee and Arkansas; abatis dike work; upper St. Francis and Reelfoot levee districts, and lower St. Francis levee district to the one hundred and thirty-ninth milepost.

The second district extends from the foot of Island 40 to the mouth of White River (393 R.), a distance of 173 miles, excepting on the left bank, where it ends at the Coahoma-Bolivar County line (365 L.). Operations in this district include bank revetment work at Memphis, Tenn., and Hopefield Bend and Helena, Ark.; the improvement of Wolf River, Tennessee; the White River and upper Yazoo levee districts, and the lower part of the lower St. Francis levee district.

The third district extends from the Coahoma-Bolivar County line on the left bank (365 L.) and the mouth of White River on the right bank (393 R.) to the latitude of Warrenton, Miss. (607 L.). Its operations include bank-revetment work at Lake Bolivar front, Ashbrook Neck, and Greenville Harbor, Mississippi, and Lake Providence and Delta Point, Louisiana, the abandoned work of systematic improvement of Lake Providence Reach, and the Lower Yazoo and Upper Tensas levee districts.

PART I.—CHANNEL WORK.

FIRST DISTRICT (CAIRO TO FOOT OF ISLAND 40, 220 MILES).

Columbus, Ky. (*21 L.*).—(For description and previous history see p. 3580, Report Chief of Engineers, 1891.) Special appropriation. This work (see map No. 1 herewith) consists of a series of five spur dikes protecting about 2,200 feet of bank in front of the town. No work has been done since 1890, and the present conditions are fairly good and as stated in the last annual report.

Hickman, Ky. (*36 L.*).—(For description and previous history see Reports Chief of Engineers, 1890, p. 3197; 1895, p. 3756; 1902, Supplement, p. 91.) Special appropriation. This revetment (see map No. 2 herewith) was placed in 1889, 1892, and 1894 and includes 1,450 feet of effective revetment, of which 800 feet is old-style woven mattress and 650 feet fascine mattress. The work is in satisfactory condition.

New Madrid, Mo. (*71 R.*).—(For description and previous history see Reports Chief of Engineers, 1894, p. 2859; 1895, p. 3757; 1897, p. 3696; 1899, p. 3504; 1900, p. 4784.) Special appropriation. This work (see map No. 3 herewith) consists of 4,450 feet of effective revetment, all of fascine mattress, and is generally in good condition excepting at a few places near the low-water line, where the brush is somewhat decayed. This will be repaired whenever the stage of water is sufficiently low. A recent change in the channel crossing just above the town threatens the upper end of the revetment work, which may have to be extended about 1,000 feet upstream. For this purpose $20,000 appropriated in the river and harbor act of 1902 will be available during the next two years.

Caruthersville, Mo. (*110 R.*).—(For description and previous history see Reports Chief of Engineers, 1899, p. 3504; 1900, p. 4384, and 1903, Supplement, p. 169.) Special appropriation. This work (see map No. 4 herewith) consists of four dikes and about 2,300 feet of effective revetment, all of fascine mattress. This revetment is in good condition with the exception of some scalping of the bank above the pavement, which occurred during the overflow of April, 1904. The heavy caving immediately below the revetment continued until October last, but since then the bank has been nearly stationary. The lower end of the revetment is likely to be destroyed, however, by caving due to eddy action at its foot, and there are some signs of bank caving above the revetment which may make necessary an upstream extension about 1,000 feet long. No funds are available for further work here.

Plum Point Reach (*147 to 186 miles below Cairo*).—(See map No. 5 herewith.)—The works of improvement in this reach extend from above Daniels Point to near Craighead Point, Arkansas, a distance of about 20 miles (151-171). These operations were begun in 1882 and have been fully described in subsequent reports. In general terms, the work done has been the closure of Osceola and Bullerton chutes by pile dikes, the partial closure of Gold Dust Chute by pile dikes and a brush-and-stone dam, the contraction of the low-water channel by dikes at Ashport bar, Elmot bar, and Plum Point; the revetment of caving banks above Daniels Point, throughout Ashport and Fletchers Bend, along a part of the fronts of Osceola and Bullerton bars, at Plum Point, and near Craighead Point; and the construction of levees along both banks of the river. From funds appropriated by the sundry civil bill of March 3, 1903, the Commission allotted $69,000, as follows:

Daniels Point	$10,000
Ashport Bend	8,000
Fletchers Bend	15,000
Osceola bar	36,000
	69,000

With the subsidence of the June rise it was found that serious damage had been done by the overflows of 1903 to the old woven mattress revetment work at Fletchers Bend, and the $36,000 allotted to Osceola bar was transferred to that work, which is considered the most important in the reach.

Daniels Point, Arkansas (*152 R.*).—(For description and previous history see Report of Chief of Engineers, 1903, Supplement, p. 170.) (See map No. 6 herewith.) Until recently this revetment extended about 8,800 feet upstream from Daniels Point, but during the past two years the lower 4,000 feet has been practically destroyed, only a few detached pieces of revetment remaining. Operations during the past year were carried on under an allotment of $10,000 from the appropriation of March 3, 1903, and consisted of minor repair work. Four connecting mats and three crib dikes were placed, 339 linear feet of bank graded, and 246 linear feet of bank paved, all near the foot of the 1895 revetment.

The cost of the season's work was $4,415.49. (For further details see report of Asst. Engineer A. J. Nolty, Appendix 2 A, herewith.)

At present the effective continuous revetment is 5,600 feet long, of which the upper 4,800 feet is of fascine mattresses and the lower 800 feet of dikes and small fascine mattresses combined. About 2,000 feet below are some small detached fascine mattresses.

The caving below the upper work appears to have ceased, and there is no apparent necessity for replacing it. No operations are contemplated for the coming season.

Ashport Bend, Tenn. (*155 L.*).—(For description and previous history see Reports Chief of Engineers, 1900, p. 4785; 1903, Supplement, p. 170.) This bend (see map No. 7 herewith) has a continuous revetment about 16,450 feet long, of which about 7,500 feet at the lower end is of fascine mattresses, and the remainder of woven mattresses. It is all in effective condition. Work was carried on during the past season under an allotment of $8,000 from the appropriation of March 3, 1903, and consisted in completing the repair work, started during the previous season, by placing a pocket mat 111 by 120 feet. After the subsidence of the 1903 flood the bank for a considerable distance was found to be scalped from the top of the pavement for some distance back, and in places the bank behind the paving had been scoured away. To prevent further erosion of this description 10 crib dikes were constructed from the upper edge of the paving to the crest of the bank, and willows were planted at 15-foot intervals for the purpose of inducing a natural growth. The total cost of the season's work was $5,428.99. (For further details see report of Asst. Engineer A. J. Nolty, Appendix 2 A, herewith.)

Fletchers Bend, Ark. (*158-161 R.*).—(For description and previous history see Reports of Chief of Engineers, 1900, p. 4786; 1903, Supplement, p. 170.) Until recently this revetment (see map No. 8 herewith) was 17,300 feet long, but during the last two years about 4,400 feet of woven mattress revetment built in 1884-1891 has been destroyed, while about 2,000 feet of fascine mattress revetment has been built to partially replace it.

Operations during the season were carried on under allotments of $15,000 from the appropriation of March 3, 1903, and of $36,000 from the same appropriation, originally allotted to Osceola bar and later transferred to this work. Two fascine mattresses were sunk—one, 705 feet long, just above, and one, 778 feet long, just below the 1902 work. A pocket cave at the shore edge of the 1899 revetment, near the head of the work, was repaired with fascine pocket mattresses. The total cost of the season's work was $41,216.28. The cost per linear foot of new revetment was $27.79. (For further details see report of Asst. Engineer A. J. Nolty, Appendix 2 A, herewith.)

The programme of work during last season was carried out successfully and without incident as far as practicable with available funds. At the end of the 1902-3 season 10,068 cubic yards of stone were left stored on the revetted bank, which afterwards gave way, and out of the lot only 2,137 cubic yards were recovered, the net loss being 7,931 cubic yards. Much difficulty was experienced throughout the working season in obtaining a sufficient supply of stone, and for this reason the cost of the work was somewhat increased. The present effective revetment has a total length of 14,900 feet, of which 7,550 feet consists of groins, dikes, and woven mattresses, and 7,400 feet of fascine mattresses. Below the 1903 work is a gap 2,500 feet long, where the old woven mattresses have been destroyed and which it is intended to replace with new revetment during the coming season. For about 2,800 feet below this gap the revetment consists of old woven mattresses built in 1891, which are beginning to show signs of weakness. This will be reinforced with fascine mattresses as far as practicable with available funds, as by doing the work before the old revetment is destroyed the bank paving is saved and the cost reduced about half.

Osceola bar (*163 R.*).—(For description and previous history see Reports of Chief of Engineers, 1896, p. 3600; 1903, Supplement, p. 170.) This revetment (see map No. 9 herewith) was until recently about 7,700 feet long and consisted of 3,750 feet of fascine mattress revetment, below which was about 4,000 feet of woven mattress revetment. About two years ago this revetment was attacked at its head, and since that time almost the entire fascine mattress revetment has been destroyed. The present effective revetment consists of about 300 feet of fascine mattress revetment and about 4,000 feet of woven mattress work. This woven mattress revetment, while still in place, is not subject to current attack, being below the projecting point at the foot of the fascine revetment. Should the point be carried away the woven mattress revetment would be rapidly destroyed and the caving would continue downstream and destroy the Lower Osceola and Bullerton revetments.

No work was done here during the year, although a new fascine mattress revetment to replace the lost work was contemplated, and an allotment for that purpose of $36,000 was made from the appropriation of March 3, 1903. This allotment was later transferred to the Fletchers Bend work on account of the greater necessity at the latter place. During the year the destruction of the 1895 fascine mattress revetment has continued, but at a reduced rate.

About 2,000 feet of new revetment is needed at the head of this work for its proper protection. This should by all means be done, if possible, during the coming season, as the present bank line is unusually good.

Lower Osceola and Bullerton bars, Ark. (*165-168 R.*).—The revetment at this place (see map No. 10 herewith), 14,300 feet long, is all effective, and consists of 3,100 feet of woven mattress revetment and 11,200 feet of fascine mattress revetment. The fascine revetment on Bullerton bar is notable as being the first extensive fascine mattress work done on the Mississippi River. It was placed in 1893-94, is in excellent condition, and has cost absolutely nothing for maintenance or repairs.

Abattis dikes.—No allotment was made for the construction of abattis dikes during the past season, but an examination of the dike at Island 14 (183 R.) (see map No. 11 herewith), placed during the season of 1902-3, disclosed a gap about 200 feet wide, where a section had been torn away during the 1903 overflow. This was replaced in January, at a cost of $1,131.83, funds being available from a small balance from the previous season's work. (For further details see report of Asst. Engineer A. J. Nolty, Appendix 2 A, herewith.)

SECOND DISTRICT (FOOT OF ISLAND 40 TO WHITE RIVER, 173 MILES).

Hopefield Bend, Ark. (*227-230 R.*).—(For description and previous history see Reports of Chief of Engineers, 1900, p. 4787; 1903, Supplement, p. 172.) The revetment at this place (see maps Nos. 12 and 13 herewith), originally extending a distance of 16,600 feet from Mound City Chute to Hopefield Bend, is essential to the maintenance of deep water in Memphis Harbor. From station 0 upstream to Mound City Chute, a distance of 6,300 feet, the revetment was of light woven mattresses built in 1883-1885, and is either destroyed or so weak as to be entirely useless. From station 0 downstream, a distance of 4,000 feet, the revetment is of diagonal woven mattresses built between 1887 and 1892, and has failed in places, and shows signs of general weakness. Below this the revetment consists of 6,300 feet of fascine mattresses, which, when the bank was last exposed, was in thoroughly good condition.

Work during the season was carried on with an allotment of $99,000 from the appropriation of March 3, 1903, and consisted of about 2,600 feet of new fascine-mattress revetment extending upstream from a point about 1,300 feet above station 0, and replacing a part of the destroyed woven mattresses built in 1883-84. In addition, a connecting mat 840 feet long and 116 feet wide was placed downstream, from a point 900 feet below station 0, to repair breaks in the 1891 revetment. There were also placed 18 connecting mats, this large number being rendered necessary by the continuous caving during the progress of the work, which made the bank line extremely ragged.

The work done this season was carried on under great difficulties on account of the constantly caving bank and the strong current, ranging from 6 to 8 feet per second. Channel mats Nos. 1 and 2, respectively 1,000 feet and 1,130 feet long, and 254 feet wide, were successfully sunk, with current velocities between 6 and 8 feet per second. Channel mat No. 3, 915 by 254 feet, built with especial care, and sunk in a current of 6 feet or less per second, was broken in sinking and the lower 765 feet lost. The cause of this loss is difficult to determine, but it was doubtless due to the following combination of adverse circumstances: While the mattress was being constructed a raft of 40 (estimated) saw logs was forced under the head barges and lodged under and about 200 feet below the head of the mattress. While the head of the mattress was being lowered, the towboat *Chisca* was blown onto it, and hauled off after an hour's work. This dragging over the mat caused some damage, and probably weakened the outer edge at the place where the rupture afterwards started. After the boat was released and the head of the mat successfully sunk, and almost the entire mat below the surface, a large cave occurred just abreast of the line of rupture, and the weight of falling earth, estimated at several thousand tons, fell on the inner part of the mat, forced it away from the bank, and caused unusually heavy strains on the outer edge. At about the same time a number of the saw logs previously lodged under the mat were forced through and appeared on the surface. The rupture of the mat started at the outer edge, the mat was torn across to the bank, and the lower part drifted downstream, was guided by the towboat below the bridge, and lodged on the head of Presidents Island. The value of the mat lost was $11,359.42.

The remaining channel work of the season, of a minor character, was completed successfully and without incident. The bank was graded to a slope varying from 1 on 2½ to 1 on 3, the slope being carried to within 6 feet of the top of the bank. The paving was of the standard type adopted in the first and second districts, and consisted of a closely pitched layer of stone 7 to 8 inches thick on a bed of quarry spalls 3 to 4 inches thick. The paving was carried to stages varying from 20 to 27 feet on the Memphis gauge, the particular height being governed by the character of the soil, the paving being carried above all sandy strata to the hard clay at the top of the bank.

Much difficulty and delay was experienced in obtaining a sufficient quantity of stone, and this added materially to the cost of the work. Before final suspension of the work the plant had to be twice withdrawn to Wolf River on account of floating ice, which filled the river from bank to bank for several days on each occasion. The total cost of the season's work was $101,295.47. The cost of completed new revetment was $26.29 per linear foot. (For further details see report of Asst. Engineer W. M. Rees, Appendix 2 B, herewith.)

In its present condition this revetment contains 12,900 feet of effective revetment, of which 8,900 feet is fascine mattress work, 800 feet woven mattress reinforced with a half width of fascine mattresses, and 3,200 feet unprotected woven mattresses. The gap from station O up to the last season's new work will have to be revetted during the coming season, and the head of the work should be extended upstream, perhaps as far as Mound City Chute. The unprotected woven mattresses below station 0 should be reinforced with fascine mattresses, as they are almost certain, if left in their present condition, to be destroyed in the next year or two, and the reinforcing can be done at about half the cost of new work.

Wolf River, Tenn. (*230 L.*).—(For description and previous history see reports of Chief of Engineers, 1893, p. 2136; 1895, p. 1703; 1902, Supplement, p. 93; 1903, Supplement, p. 172.) Special appropriation. The object of this improvement is the maintenance by dredging of the navigable channel to the county bridge, 2¼ miles above the river mouth, the work being done with Government plant and hired labor.

Work during the year was carried on under an allotment of $8,000 from the appropriation of March 3, 1903. Operations were carried on from September 29 to January 13, and resulted in the removal of 52,340 cubic yards of earth at a cost of 12.48 cents per cubic yard, and 153 snags, etc., at a cost of $5.72 apiece; the total expenditure being $7,417.62.

The plant belonging to this work is in bad condition, and its proper repair will take nearly all of the remaining balance belonging to the work. No funds are available for continuance during the coming low-water season, but an estimate of $8,000 has been submitted to the Chief of Engineers with a view to its allotment from the funds appropriated by the emergency river and harbor act of April 28, 1904. (For further details see report of Asst. Engineer W. M. Rees, Appendix 2 B, herewith.)

Memphis Harbor, Tenn. (*230–232 L.*).—(For description and previous history see reports of the Mississippi River Commission since 1882.) The work at this place (see maps Nos. 12 and 14 herewith) is the protection of between 2 and 3 miles of the city front. A total of 14,800 feet of protection work has been constructed, of which the upper part is now covered by a sand bar. This silted up revetment is of woven mattresses and would probably be destroyed if subjected to current attack. The present effective revetment is 9,900 feet in length, and includes 4,100 feet of woven mattress revetment, 2,100 feet of dike work, and 3,700 feet of fascine mattress work. The sand bar covering the upper part of the city front has, during the last year, increased in height an average of 0.4 feet and has decreased in area about 5½ acres, the area lost being a strip of about 80 feet average width extending for 3,000 feet from the foot of the bar upstream. This cutting away of the bar is evidently due to a movement upstream of the channel crossing from Hopefield Bend, caused by the recent recession of the bank line at the latter place. While there may be some further cutting away of the bar, it is believed that conditions are nearing a state of equilibrium which can be maintained as long as Hopefield Bend is held in its present shape.

The condition of the revetment work is generally good; no work was necessary during the past year and none is contemplated for the coming season.

Helena, Ark. (*306 R.*).—(For description and previous history see reports of Chief of Engineers, 1890, p. 3212; 1897, p. 3701; 1899, p. 3508; 1900, p. 4789; 1903, Supplement, p. 173.) Special appropriation. The work at this place (see maps Nos. 15, 16, and 17 herewith) consists of 4,900 feet of bank revetment, of which 1,400 feet is dike work, 450 feet woven mattress work, and 3,050 feet fascine mattress work. Where mattresses have been used the revetment work is generally in good condition, but along the bank protected by dikes, sloughing has continued to a serious extent. Early last fall two pocket caves, each about 175 feet long, occurred between Dikes 2 and 3, and in December, with the river at the 3 feet stage, the bank back of the dikes settled along a distance of 1,000 feet below Dike 3, the greatest width of settling being about 125 feet, and the greatest depth of settling about 20 feet.

The bank line back of this settling is now dangerously near the levee.

A series of borings developed the fact that at a depth of 40 to 50 feet below the surface a stratum of quicksand exists, which, during very low stages, is being slowly forced toward the river by the weight of the earth above. From time to time these settlements occur as a result. It would seem that the mattress revetment tends to hold the quicksand in place, as most of the settlement has occurred back of the dike work. The solution of the problem here presented is under careful consideration now, and it is expected that some plan to relieve the situation will be decided on as soon as the river falls sufficiently, probably within the next month. The amount of available funds was too small to permit any extensive work, and the only thing attempted during the past season was the revetting of the two deep pockets between Dikes 2 and 3 with fascine mattresses, and the construction across each of these pockets of a crib dike to break up eddy action. The total cost of the season's operations was $7,189.24. (For further details see report of Asst. Engineer W. M. Rees, Appendix 2 B, herewith.) Amount available for work during coming season, $10,000.

PLANT, FIRST AND SECOND DISTRICTS.

Repair work on plant was continued during the year with the unexpended balance from the previous year, an allotment from the appropriation of March 3, 1903, and a transfer from funds previously allotted to third district.

The only new work was the construction of one flat, 60 by 16 by 4 feet. The principal work was the reconstruction and repair of deteriorated plant begun during the previous year, and the general conditions have been greatly improved. The expenditures during the year ending April 30 were as follows:

Care of plant	$12,112.74
New flat	650.00
Repairs to plant	75,038.69
	87,801.43

Steamer Unique.—The small propeller steamer *Unique* has been purchased at a cost of $14,000, one half from plant allotment to first and second districts and one-half from plant allotment to third district. This steamer was built by the Ward's Engineering Works of Charleston, W. Va., and has a steel hull 90 feet long, 14 feet beam, 4½ feet depth, 28-inch draft, 18¾ feet width over guards. The boiler is tubular, with outboard condensers. The engine is triple expansion of a very compact type, developing about 200 horsepower, with a coal consumption of about 2 pounds per indicated horsepower. The propeller is 46 inches in diameter and operates in a recess built into the hull which completely protects it from drift. This steamer is of a type radically different from anything in use on the Mississippi River, and in addition to utilizing it for surveying and inspection purposes it is proposed to conduct a series of experiments to determine the value of this type for towboats and other vessels in use on commission work.

With the allotment already made for the coming season almost the entire plant will be placed in thoroughly serviceable condition. (For further details see report of Asst. Engineer A. J. Nolty, Appendix 2 C, herewith.)

THIRD DISTRICT (WHITE RIVER TO WARRENTON, MISS., 214 MILES).

Lake Bolivar Front, Miss. (*417 L.*).—(For description and previous history see Report Chief of Engineers, 1903, Supplement, p. 220.) The effective revetment at this place (see map No. 33 herewith) is 3,775 feet long and of woven mattresses. The revetment is in generally good condition, the only work necessary during the past season being the minor repair of numerous small breaks due to wave wash and surface water from the bank. Cost of season's operations, $1,056.75, from allotment for general repairs to existing works. (For details see report of Asst. Engineer Arthur Hider, Appendix 2 D, herewith.) No work is contemplated during the coming season.

Ashbrook Neck, Miss. (*446 L.*).—(For description and previous history see Report Chief of Engineers, 1903, Supplement, p. 220.) This revetment (see map No. 34 herewith) was built to prevent a cut-off, and is 10,100 feet long, of which 2,000 feet is of old woven mattresses, 7,600 feet of woven mattresses reinforced with fascine mattresses, and 500 feet of original fascine mattresses.

The principal work during the past year was the placing of 2 fascine mattresses 250 feet wide and respectively 1,000 and 830 feet long to reinforce old woven mattresses before they could give way, a policy that has been successfully followed in the third district for several years, and which results in saving about half the cost of replacing old woven mattresses after their destruction.

Other repairs made were of a minor character, including restoration of bank paving, damaged by wave wash or surface water from the bank. Expenditures for the year, $38,086.61, from allotment of $50,000 from appropriation of March 3, 1903.

(For further details see report of Asst. Engineer Arthur Hider, Appendix 2 D, herewith.)

The general condition of this revetment is excellent; two sections of woven mattress revetment, respectively 1,150 and 900 feet long, are still to be reinforced, but this work is not urgent.

Greenville Harbor, Miss. (*478 L.*).—(For description and previous history see Report Chief of Engineers, 1903, Supplement, p. 221.) Special appropriation. This revetment (see map No. 35 herewith) has an effective length of 12,100 feet, of which 1,400 feet is of old type woven mattresses and 10,700 feet of woven mattresses reinforced with fascine mattresses.

The work of the past season consisted in the repair of three breaks in the upper bank, requiring regrading and repaving, and the construction and placing of a standard fascine mattress 750 feet by 225 feet to reinforce the old woven mattress between ranges 120 and 126. Cost of season's operations, $27,791.51, from allotments to this work from appropriations of June 13, 1902, and March 3, 1903. (For further details see report of Asst. Engineer Arthur Hider, Appendix 2 D, herewith.)

At least one of the upper bank breaks was probably caused by surface water from the upper bank. This revetment is in generally good condition, and, as far as can now be determined, will require no work during the coming season.

Lake Providence reach (*517-552 R.*).—This is one of the reaches originally selected by the commission for systematic improvement, and was abandoned some years ago. (For description and history see Report Chief of Engineers, 1903, Supplement, p. 221.)

Louisiana Bend, Louisiana (*522 R.*).—(For description and previous history see Report Chief of Engineers, 1903, Supplement, p. 221.) This revetment was built between 1889 and 1893 and partly repaired in 1896-97. It had a total length of 15,820 feet, but about 4,000 feet at the lower end has been destroyed. No work was done during the year, and none is contemplated.

Lake Providence, La., revetment (*540 R.*).—(For description and previous history see Report Chief of Engineers, 1903, Supplement, p. 222.) This revetment (see maps 36 and 37, herewith) protects the town of Lake Providence and the important levee across the foot of the lake, and has a total length of 12,600 feet, of which 2,200 feet is of old style woven mattresses, 700 feet woven mattresses reenforced with fascine mattresses, 5,000 feet fascine mattresses reenforced with fascine mattresses, and 4,700 feet original fascine mattresses.

Work during the past season included a channel mat 800 by 250 feet, ranges 75 to 83; a channel mat 924 by 250 feet, ranges 28 to 36, and a pocket mat of 1,353 squares between ranges 78 and 83. Total expenditures for the season's work, $46,369.46, from allotments to this work and general repairs to existing works, appropriation of March 3, 1903. (For details see report of Asst. Engineer Arthur Hider, Appendix 2 D, herewith.)

On March 13 last a cave about 700 feet long occurred in the upper bank paving at and above range 36, which probably involves the channel mat, which is of the old woven type.

The upper 4,000 feet of this revetment is now protected by the Longwood bar, which has continued its move downstream. The middle 3,000 feet is reasonably safe, while the lower mile is subject to strong current attack where the channel is narrowest. The woven mattress revetment from ranges 20 to 28 and 36 to 52 should be reenforced as soon as possible, which work will leave in the revetment no unprotected woven mattresses.

The work contemplated for the coming season includes a new mattress at the break above range 36 and reenforcing mattresses as far as practicable over the unprotected woven mattress revetment.

Delta Point, Louisiana (*598 R.*).—(For description and previous history see Report Chief of Engineers, 1903, Supplement, p. 223.) This revetment (see maps Nos. 38 and 39, herewith) has an effective length of 5,900 feet, of which 4,600 feet is woven mat, 600 feet woven mat reenforced by fascine mat, and 700 feet original fascine mat.

No work has been necessary for several seasons, but recent surveys indicate a channel movement toward the point, and caving has occurred for 4,000 feet above the head of the effective revetment, range 9 west, which, if continued, will tend to move upstream the channel crossing from Delta Point, and perhaps create a caving bank on the Mississippi side, where the levee was recently constructed, to close the West Pass from Centennial Lake. To follow this possible movement a survey of Delta Point reach (see map No. 39, herewith) was made last fall, and it will probably be the first of a series.

There is no apparent necessity for any work during the coming season.

POSSIBLE CUT-OFFS.

Four necks are under observation in order that possible cut-offs may be guarded against whenever necessary.

Caulks Neck (*410–423 R.*).—The survey of 1903 shows a recession of the upper bank line at the narrowest part of 100 feet during the year. The shortest distance across the neck is 3,800 feet. The present maximum caving is about a half mile below the narrowest part.

This neck is apparently safe for several years.

Ashbrook Neck (*446–455 L.*).—The upper side of the neck is protected by a revetment and there is no dangerous caving. The shortest distance across the neck is about 2,000 feet, and there is no present danger of a cut-off.

Carters Neck (*461–474 L.*).—The survey of 1903 shows maximum caving at the narrowest point of 300 feet during the year. The shortest distance across the neck is 3,250 feet, and there is no present danger of a cut-off.

Leland Neck (*470–484 R.*).—The survey of 1903 shows maximum caving at the narrowest part of 300 feet during the year. The distance across the neck at the narrowest part is 3,500 feet. The spur levee built to prevent cut-off by surface washout is 6,350 feet long and terminates in the woods, and as long as this levee stands intact there is no especial danger, but it has only a 6-foot crown and 2 on 5 slopes, and is exposed to wave wash, although the maximum head of water against it is only about 3½ feet. It might be well to enlarge it to standard levee section, but probably better to terrace for protection against wave wash, and it could be advantageously extended.

The upper bank at this place will almost certainly have to be revetted within two or three years, as the spur levee is less than 1,500 feet from the caving bank for a considerable distance. (For further details see report of Asst. Engineer Arthur Hider, Appendix 2 D, herewith.)

STONE, THIRD DISTRICT.

Stone for the season's work was obtained from the reserve supply at Greenville remaining from the previous year, and from the Government quarry on Little Red River, near Searcy, Ark., from which place 14,336 cubic yards had been quarried and towed to Greenville, at a cost of 83.54 cents for quarrying and loading, 62.16 cents for towing, and 16.4 cents for unloading, making the cost on barges at Greenville about $1.46 and on the bank at Greenville $1.62 per cubic yard. At the conclusion of the season's revetment work there was left at Greenville a reserve of approximately 12,000 cubic yards.

In February last the quarry was again opened and 11,376 cubic yards taken out and loaded and the greater part towed to Greenville. Quarrying has just been suspended on account of the low stage in the Little Red River and the last of the stone is now en route to Greenville, but the cost can not be computed until all the plant employed has been taken to Greenville and laid up. It will, however, probably be greater than last year.

Early work at the quarry started February 4 and by February 15 the quarry was in full operation, but it was not until March 28 that loading could be undertaken, as the usual spring rise was delayed and the water too low for earlier navigation. In the meantime, on account of the apparently poor chance for towing, a considerable part of the stone allotment had been transferred to plant account, where it could be advantageously utilized, so that when navigation became possible the available funds were sufficient to run the quarry only during part of April. To insure an adequate supply of stone for the proposed Longwood revetment, which will protect an important stretch of Lower Yazoo levee, the Mississippi levee commissioners offered to pay the expense of operating the quarry and towing as long as the stage of the river would permit. Largely on this account there is now available at Greenville nearly 25,000 cubic yards of stone, almost enough to do the contemplated work at Longwood.

The remaining stone needed for the season's work can be readily obtained from contractors in ample time for use. Expenditures during the past year, $17,411.09, from unexpended allotment of previous year. (For further details see report of Asst. Engineer Arthur Hider, Appendix 2 D, herewith.)

PLANT, THIRD DISTRICT.

During the year the plant has been maintained in serviceable condition at a cost of $27,759. The cost of caring for plant and property was $21,867.02, making a total for care and repair of $49,626.02. In addition, 12 new barges were built at a cost of

$38,208 for construction and $1,800 for delivery, and work on the new steel towboat, to cost $53,900, has been in progress at Jeffersonville, Ind. While the work on this new towboat has been very slow, it is excellent in quality, and there is every reason to expect a first-class boat. From present prospects, it will be delivered early in July. Total expenditure for plant during the year ending April 30, 1904, $93,344.15. (For further details see report of Asst. Engineer Arthur Hider, Appendix 2 D, herewith.)

Half the cost of the small propeller steamer *Unique*, described in detail under plant, first and second districts, was paid from the allotment to plant, third district.

For the coming season's work, aside from ordinary repairs and care of plant, the only work of importance under this head will be the repair of tug *Parker*, at an estimated cost of $4,500, and the repair of hydraulic grader, at an estimated cost of $2,500, for which funds have been transferred from unused balances of allotments to other works.

GENERAL REMARKS ON CHANNEL WORK, FIRST, SECOND, AND THIRD DISTRICTS.

The season's work has been generally satisfactory, although in the upper districts the destruction of old woven mattress revetment has in places progressed faster than the work of replacing with fascine revetment could be done.

In the first and second districts the principal work was done at Fletchers Bend and Hopefield Bend, where the destruction of old work has progressed rapidly during the last two years. Similar conditions exist at Osceola bar, but lack of funds prevented any work. Much remains to do at all three places, but it is hoped that the allotments for 1904–5 will permit restoration at all breaks and the reenforcement of the old revetment at the most critical points. There was no reserve stone supply in these districts at the beginning of the working season, and on account of labor conditions and the difficulties of rail transportation the contractor was unable to furnish stone as rapidly as needed. In consequence, many delays occurred and the cost of the work was correspondingly increased.

In the third district the year's work included closing breaks in the Greenville and Lake Providence revetments, and the continuation of the reenforcement of the old revetment at both places and at Ashbrook Neck. The conditions are very satisfactory at all existing revetments excepting at Lake Providence, where a new break occurred in March, and its closure and some reenforcement work will be necessary. The principal work for the coming season in the third district will be the new revetment for levee protection at Longwood, Miss.

There is little difference in construction methods in use in the districts, the only one of note being the use in the first and second districts of spalls as a foundation for the bank paving. This apparently gives the best results, and where used repairs to paving are rarely necessary, excepting in case of mattress failure, while in the third district the repair of damages to paving from wave wash and surface water is annually necessary.

A comparison of conditions in the first and second districts with those in the third district indicates that the latter is far in advance, evidently because, with approximately equal allotments during recent years, nearly three times as much revetment had to be maintained in the first and second districts as in the third. Repair work on the plant belonging to the first and second districts, started two years ago, has progressed as far as funds permitted, and with the allotment from 1904–5 appropriation its condition will approximate that in the third district, which is in excellent shape.

The rapid deterioration of wooden hulls suggests the advisability of using steel in future barge construction. The first cost will be considerably greater, but from the experience with towboats, it is believed that the difference will be more than saved within five years. It is recommended that, if funds are available, the construction of a few steel barges be authorized annually hereafter.

PART II.—LEVEE WORK.

FIRST AND SECOND DISTRICTS, (CAIRO TO WHITE RIVER, 393 MILES).

Upper St. Francis levee district (*0-70 R.*).—(For description and previous history see Report Chief of Engineers, 1903, Supplement, p. 174, and report of Asst. Engineer Chas. Le Vasseur, Appendix 2 E, herewith.) (See map No. 18, herewith.) This district properly begins at Commerce, Mo., but only the part south of Cairo is under the Commission's jurisdiction. The local levee board has petitioned to have the Commission's jurisdiction extended to the head of the territory subject to overflow.

When completed, the levee below Cairo will be about 54 miles long, and will protect about 700 square miles.

To the end of last year about 5.4 miles had been built south of Cairo, and during the year, with an allotment of $20,000 from the appropriation of March 3, 1903, the sixth mile was completed by an addition of 90,000 cubic yards by the United States and 5,100 cubic yards by the levee board. The levee board also constructed, under the supervision of this office, a culvert through the levee to drain Lake Brewer, at a cost of about $7,500. (See plans Nos. 24 to 29, inclusive, herewith.)

Summary of earth in place.

	In place Apr. 30, 1903.	Added during year.	In place Apr. 30, 1904.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
By United States	287,198	90,000	377,198
By levee board and others	278,700	5,104	283,804
Total	565,898	95,104	661,002

The amount given as in place April 30, 1903, by the levee board and others, includes the contents of a private levee 7½ miles long, built back of Wolf Island (25 R.) some years ago by private parties living in the vicinity, which will be incorporated in the permanent line.

Nothing was lost or abandoned on account of caving banks or other causes.

The project for the expenditure of $20,000, allotted from the appropriation of March 3, 1903, was approved, with the condition that the levee board should provide suitable drainage for Brewer Lake, the outlet of which has been cut off by the extension made during the past year. At the request of the levee board, plans for a concrete-steel culvert were prepared in this office, and, having received the approval of the Commission, work was undertaken by the levee board under United States inspection, and at the time of the overflow last April had been nearly completed, but not sufficiently so to make a test during the rise.

Under an appropriation of $15,000 from the appropriation of April 28, 1904, for fiscal year 1904-5, bids were opened April 25 for about 120,000 cubic yards of new levee from stations 10/35 to 15/38, and the lowest bid, of 11.4 cents, by Talley, Bates & Watkins, was accepted. Contracts have been prepared and forwarded for approval.

The levee board has also contracted for work during the coming season as follows: Forty thousand cubic yards from stations 6/0 to 6/19, and 83,000 cubic yards from stations 10/35 to 18/44, the latter point the beginning of the private levee back of Wolf Island, which is 7½ miles long. The last portion, 83,000 cubic yards, will be paid for from funds subscribed by residents of the vicinity. It is probable that the levee board will later this season close the gap between stations 6/10 and 10/35, and also extend the Wolf Island levee so as to give nearly 30 miles of continuous levee south of Cairo.

To complete the Upper St. Francis levee below Cairo will require the addition of about 4,500,000 cubic yards of embankment at an estimated cost of approximately $600,000. (For details see report of Asst. Engineer Chas. Le Vasseur, Appendix 2 E, herewith.)

Reelfoot levee district (36-60 L.).—(For description and previous history see Report Chief of Engineers, 1903, Supplement, p. 174, and report of Asst. Engineer Chas. Le Vasseur, Appendix 2 F, herewith.) (See map No. 18, herewith.) This levee when completed will be about 21 miles long and protect about 310 square miles. To the end of the present year 5½ miles have been built at the upper end and about 4 miles at the lower end.

With an allotment of $20,000 from the appropriation of March 3, 1903, contract was made with M. J. Roach & Co. to extend the levee from stations 4/0 to 5/33, and 113,749 cubic yards were placed, at a cost of 14 cents per cubic yard. The Fulton County levee board of Kentucky, under United States supervision, repaired 2 miles of levee built by the United States the previous year and damaged during the overflow of 1903, and also extended the levee from stations 2/7 to 4/0, placing a total of 105,060 cubic yards. No work was done during the year by the Lake County levee board of Tennessee.

Summary of earth in place.

	In place Apr. 30, 1903.	Added during year.	Total.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
By the United States	141,912	113,749	255,661
By the levee boards	440,710	105,060	545,770
Total	582,622	218,809	801,431
Lost during overflow of 1904			12,300
In place Apr. 30, 1904			789,131

Under an allotment of $15,000 from the appropriation of April 28, 1904, for fiscal year 1904–5, bids were opened April 25, 1904, for about 120,000 cubic yards of levee work from stations 5/33 to 7/0 and from 8/0 to 8/45, and the lowest bid, of 10.89 cents, by Denison & Shafer, was accepted, and contracts have been prepared and forwarded for approval.

The Fulton County levee board of Kentucky is expected during the year to place 42,000 cubic yards from stations 7/0 to 8/0, and the Lake County levee board of Tennessee is expected during the year to repair the damages from the April overflow and extend the lower levee about a half mile north to the State line.

After the present year's work there will be required to complete this levee a total of 1,300,000 cubic yards, at an estimated cost of $195,000. (For details see report of Asst. Engineer Chas. Le Vasseur, Appendix 2 F, herewith.)

Lower St. Francis levee district (79–298 R.).—(For description and previous history see Report of Chief of Engineers, 1903, Supplement, p. 174) (See maps Nos. 18, 19, and 20 herewith.) When completed this levee will be about 213 miles long and will protect about 3,500 square miles. To date about 178 miles of continuous levee have been built from Point Pleasant, Mo. (79 R.) to 258 R., and a lower section about 15 miles long from Bledsoe (269 R.) to Whitehall (281 R.), leaving between the two a 13-mile gap now being closed, and about 7 miles at the end of the line near the mouth of the St. Francis River, on which no work has been done.

At the beginning of the year there remained unfinished five of the 1902–3 contracts on which 271,126 cubic yards had been placed and 318,621 cubic yards remained to be done. These were all finished during the year with the exception of one contract from stations 11/0 to 15/0, which requires 24,882 cubic yards for completion. Under allotment of $125,000 from the appropriation of March 3, 1903, contracts were made and executed as follows:

	Cubic yards.
Stations 8/0 to 11/0	96,033
Stations 15/0 to 17/0	77,500
Stations 28/34 +65 to 29/40+35	118,459
Stations 51/0 to 51/42	26,905
Stations 83/44 to 83/51	7,996
Stations 127/28 to 134/0	230,000
Total	556,893

Of these contracts all are completed, excepting one from stations 15/0 to 17/0, on which 8,946 cubic yards remains to be placed, and one—stations 127/28 to 134/0—which requires 178,867 cubic yards additional. In the latter case the contractor was given an extension in order to allow him to undertake the construction of an emergency loop just below Caruthersville (stations 28/34+65 to 29/40+35), where the old levee was threatened by caving bank and was breached during the April overflow. A contract for enlarging the levee stations 5/0 to 8/0 was made, but when the emergency at Caruthersville arose it was canceled by mutual consent in order to provide funds for the latter work.

Summary of earth in place.

	In place Apr. 30, 1903.	Added during year.	Total.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
By the United States	4,551,054	683,057	5,234,111
By the levee board	9,414,044	657,817	10,071,861
Total	13,965,098	1,340,874	15,305,972
Lost or abandoned			56,000
Total in place Apr. 30, 1904			15,249,972

The proposed enlargement and extension of the Walnut Bend levee under special appropriation of June 13, 1902, has not yet been contracted for because the locality of the work is threatened by a rapidly caving bank. A survey of this locality is now being made, and report will be submitted in the near future. It is probable that the bank for about 3,000 or 4,000 feet below Whitehall Landing (280 R.) will have to be revetted; otherwise, not only will the levee be breached, but a cut-off nto the St. Francis River will be made at a point about 25 miles above its mouth, which will raise the back-water level of that stream about 8 or 10 feet. The caving bank at Whitehall is only about a mile from the St. Francis River, is receding about 100 feet annually, and is only about 1,500 feet from the levee. It is doubtful if the levee can be moved back on account of the swampy character of the country between its present site and the St. Francis River.

At an angle near the head of the St. Francis levee (Stations 15/35—64 to opposite 94 R.), three spur dikes were constructed in 1899–1900 to prevent erosion of the levee by eddy action of parallel currents. During the 1903 high water these dikes were only partially successful, and a training wall of creosoted lumber is now being constructed. (For details of training wall see report of Asst. Engineer Chas. Le Vasseur, Appendix 2 H, herewith, and plans Nos. 30 and 31, herewith.)

Under the allotment of $140,000, appropriated April 28, 1904, for the fiscal year 1904–5, bids were opened April 13 and April 25, 1904, for about 700,000 cubic yards of new levee and enlargement. Bids have been accepted for all of this work and contracts have been prepared and forwarded for approval. To complete this levee will require the addition of 8,800,000 cubic yards at an estimated cost of $1,600,000. (For further details of levee work see report of Asst. Engineer A. F. Kilpatrick, Appendix 2 G, herewith.)

Memphis railroad embankments.—In accordance with the Commission resolution of March 12, 1904, the effect upon the flood height of the railroad embankments opposite Memphis has been under investigation, and a special report will be submitted at an early date. The study of this question is not quite finished, but the conclusion so far indicated is that this effect is local and quite small, and probably the resulting increase in flood height is less than half a foot. This question is of some importance, as upon the Commission's decision in the matter will probably depend the passage of a law at the next session of the Arkansas legislature to compel the railroads to remove the embankments and substitute open trestle work. It is also understood that a lawsuit is contemplated by the business interests of North Memphis against the railroad companies for damages sustained from overflow due to the embankments. The Commission's decision will probably have an important effect on this lawsuit.

Upper Yazoo levee district (244–365 L.).—(For description and previous history see Report Chief of Engineers, 1903, Supplement, p. 178.) (See maps Nos. 20 and 21 herewith.) This district has 124 miles of levee, protecting an area of 3,281 square miles.

At the beginning of the year the 1902–3 contract for new loop, stations 118/10 to 120/11, amounting to 370,545 cubic yards, was only partly completed, 128,947 cubic yards having been placed, leaving an uncompleted balance of 241,598 cubic yards. Work on this contract was continued during the year until its completion in March last.

Under an allotment of $70,000 from the appropriation of March 3, 1903, a contract was made with George H. Lowrance for 300,000 cubic yards of enlargement, stations 42/16 to 50/0, and during the year 132,256 cubic yards have been placed, leaving an uncompleted balance of 167,744 cubic yards, which will be finished during the present year. This contractor was permitted to partially suspend operations at this place to enable him to do some important work in the Third district (lower Yazoo).

Summary of earth in place.

	In place Apr. 30, 1903.	Added during year.	Total.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*
By the United States	6,243,933	373,853	6,617,786
By the levee board	14,628,945	1,333,891	15,962,836
Total	20,872,878	1,707,744	22,580,622
Lost or abandoned during year			490,000
In place Apr. 30, 1904			22,090,622

Amount of yardage necessary to complete to Commission grade and section, 5,100,000 cubic yards, at an estimated cost of $1,121,000.

Under an allotment of $70,000 from appropriation of April 28, 1904, for the fiscal year 1904–5, bids were opened April 13, 1904, for 300,000 cubic yards of new levee from stations 80/44 to 82/0 (332 L.), and the lowest bid, of 17.49 cents, by Talley, Bates & Watkins, has been accepted, and contracts have been prepared and forwarded for approval. This piece of new work is on a new line to join the front line at station 80/44 with the back line at its junction with the Ward Lake cross line. The local board has already contracted for the construction of the remaining 2 miles of this new line, to contain about 1,000,000 cubic yards, work on which is now in progress. The necessity for this new cross line arises from the caving bank in the chute of Island 63, and the difficulty of holding the present end of the front line, just below milepost 89/0 (339 L.), a part of which is destroyed during every overflow. (For further details see report of Asst. Engineer M. Gardner, Appendix 2 I, herewith.)

White River levee district (306 to 385 R.).—(For description and previous history see Report of Chief of Engineers, 1903, Supplement, p. 176.) (See map No. 21 herewith.) This levee is 74 miles long, of which 67 miles is controlled by the United States, the remaining 7 miles being a private levee protecting the back of Laconia Circle, which is maintained by the Laconia levee board.

There are still open in this district four of the 1897 crevasses, aggregating 10,000 feet in length. When these gaps are closed, the levee will protect an area of about 910 square miles. At the beginning of the year there were still unfinished three of the 1902–3 contracts, 96,132 cubic yards remaining to be placed, all of which were completed during the past year.

Under an allotment of $70,000 from the appropriation of March 3, 1903, six contracts were made for enlargement work, amounting to 298,712 cubic yards, all of which were completed. In addition, 54,296 cubic yards of topping were placed by hired labor.

Summary of earth in place.

	In place Apr. 30, 1903.	Added during year.	In place Apr. 30, 1904.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
By the United States	6,228,725	449,770	6,678,495
By the levee board	1,490,240	142,980	1,633,220
Total	7,718,965	592,750	8,311,715

Nothing lost or abandoned during the year.

Amount required to complete existing levees, 8,100,000 cubic yards, at an estimated cost of $2,000,000.

Under an allotment of $70,000 from the appropriation of April 28, 1904, for fiscal year 1904–5, bids were opened April 13, 1904, for 220,000 cubic yards of enlargement, stations 38/35 to 45/0, and the lowest bid of 17.40 cents per cubic yard, by W. F. Barbour & Son, has been accepted and contracts have been prepared and forwarded for approval. A portion of the 1904–5 allotment available for levee work has been reserved until an examination of caving banks can be made, after the subsidence of the spring flood, as it is probable that one or more loops must be constructed before the next high water.

The work of enlargement and topping done by the United States and the local levee boards has materially improved conditions in this district, but the levee is still much too low, and a very large part of it is deficient in section, having narrow crowns and steep slopes, the absolutely necessary grade having been obtained by topping. In addition, four of the 1897 crevasses, aggregating 10,000 feet in length, are still open, and their closure alone will require about 600,000 cubic yards, at an estimated cost of about $125,000. As a district, the conditions existing in the White River district are worse than in any district north of Vicksburg. (For further details see report of Asst. Engineer M. Gardner, Appendix 2 J, herewith.)

CAVING BANKS, FIRST AND SECOND DISTRICTS.

Caving banks under observation during the year are described in detail in the accompanying reports of Asst. Engineer Charles Le Vasseur (Appendix 2 L) for Upper St. Francis, Reelfoot, and Lower St. Francis districts, and of Asst. Engineer M. Gardner (Appendixes 2 I and 2 J) for Upper Yazoo and White River districts.

In the Upper St. Francis and Reelfoot districts there is no serious caving affecting levees in place. In the Lower St. Francis district there is heavy caving in progress at Point Pleasant (79 R.), River Styx (140 R.), and Walnut Bend (280 R.). New loops are under contract at Point Pleasant and River Styx, and at Walnut Bend the bank will probably have to be revetted during the next two years to prevent the loss of the levee and a cut-off into the St. Francis River. Caving is also in progress near Caruthersville (110 R.), at and above Pecan Point (196 R.), and at Harrisons Landing (220 R.), but the levees are not at present threatened.

In the Upper Yazoo district the only levee threatened by caving banks is at Polks Landing (266 L.), which will be cared for by the levee board if necessary. In the White River district the sloughing off at Helena is dangerously near the levee, and a new loop and an addition to the revetment will probably be necessary during the present season. At Westover (319 R.) and Old Town (325 R.) slow caving is in progress very close to the levee, and new loops may be necessary at either or both places during the present season. From Ferguson's Landing to Wood Cottage (364–5 R.) heavy caving is in progress and a new loop will probably be necessary the present season.

With the exception of the caving bank at Walnut Bend (280 R.), provision has or can be made for all caving banks excepting in the White River district, where some chances will have to be taken during the next year or two, as has been the case in the past on account of the very limited resources of the local boards and the smallness of the allotments to this district.

HIGH-WATER OPERATIONS, FIRST AND SECOND DISTRICTS.

The only overflow during the year occurred in the month of April and was not of a serious character, although involving some expense for levee defense. The course of the overflow was as follows:

	Danger line.	Passed danger line.	Maximum.		Repassed danger line.
			Height.	Date.	
Cairo	45	Mar. 30	49.1	Apr. 5	Apr. 14
Columbus	39	Mar. 28	43.9	Apr. 5	Apr. 17
New Madrid	34	Mar. 29	38.6	Apr. 5	Apr. 18
Cottonwood Point	32	Mar. 29	38.2	Apr. 8	Apr. 21
Fulton	30	Mar. 31	37.4	Apr. 10	Apr. 22
Memphis	33	Apr. 3	39.2	Apr. 11	Apr. 22
Mhoon	36	Apr. 4	40.3	Apr. 12	Apr. 23
Helena	42	Apr. 5	47.6	Apr. 14	Apr. 26
Sunflower	40	Apr. 5	44.5	Apr. 16	Apr. 28
White River	43	Apr. 3	49.5	Apr. 18	May 20

As compared with previous overflows, the maximum stages were as follows:

	1882.	1897.	1903.	1904.
Cairo	51.87	51.70	50.60	49.10
New Madrid		40.20	39.50	38.60
Fulton	36.69	37.50	40.10	37.40
Memphis	35.15	37.60	40.10	39.20
Helena	47.20	51.80	51.00	47.60
White River	47.80	52.40	53.70	49.50

Upper St. Francis levee district.—The maximum stage along the levee was about 1 foot lower than in 1903. The levee below Cairo was protected under the supervision of this office at an expense of $450, paid by the local levee board. Area overflowed, about 270 square miles.

Reelfoot levee district.—Maximum stage about 1 foot lower than in 1903. The upper levee was protected under the supervision of this office, and the lower levee by the Lake County levee board of Tennessee. The expense of protecting the upper levee was $597.20, paid by the United States, and $110.50, by the Fulton County board, of Kentucky—a total of $707.70. The high-water expenses of the Lake County board have not been reported. In this district about 12,300 cubic yards of levee were lost at the exposed ends. Area overflowed, 308 square miles.

Lower St. Francis levee district.—In this district alone was there any danger from crevasses or overtopping. The levee from Point Pleasant to milepost 98 was protected by the United States, and from milepost 98 to the end of the line by the St. Francis levee board, their principal work, however, being confined to the stretch from milepost 98 to milepost 150, opposite Memphis. At Point Pleasant a small emergency levee was built to prevent entrance of flood water through a small depression above the town, left exposed by caving in of 1,500 feet of levee at the head of lower St. Francis line. Operations from Point Pleasant to Barfield, 57 milepost, consisted principally in guarding against damage from wave wash.

From Barfield, 57 milepost, to Nodena, 98 milepost, the conditions were serious, especially at Luxora, Ark., where for a time the levee was in serious danger of breaching, on account of the wave wash. From Nodena, 98 milepost, to opposite Memphis, the flood level was in places close to the top of the levee, and considerable damage was caused by wave wash. High-water expenses in this district by the United States were $4,609.27; by the lower St. Francis levee board of Arkansas, $8,000; total, $12,609.27. Area overflowed, 450 square miles.

Upper Yazoo levee district.—Along the upper Yazoo front the flood level varied from 0.6 to 4.5 feet below the maximum level of 1903. Levee protection was undertaken entirely by the local board, at an expense of $9,000. There were no casualties and no area overflowed.

White River levee district.—The maximum flood level along the White River front was from 3 to 5 feet lower than in 1903. High-water operations were carried on under the supervision of this office, assisted by the local authorities, at an expense by the United States of $2,227.51; by the local boards, $1,315.65; a total of $3,543.16. Area overflowed, 756 square miles, principally due to the still open 1897 crevasses, aggregating 10,000 feet in width.

The high-water organization under this office was similar to that of last year, and was very quickly and effectively placed in the field. The general plan is to place sections of about 20 miles under the supervision of an inspector, with a surveyman or rodman as assistant, the inspector having authority to employ labor as circumstances require. Larger divisions, consisting of three or more sections, were under the supervision of assistant engineers, each provided with a steamer for inspection and supply purposes, and reporting directly to the district officer. This plan is found to work more effectively and economically than any heretofore devised. When a levee is defended both by the Government organization and the levee board it has been found best for each to take separate parts of the line, so as to avoid any possible conflict of authority with its attendant demoralization at a critical time.

Area overflowed April, 1904.

	Sq. miles.
Upper St. Francis	270
Reelfoot	308
Lower St. Francis	450
Upper Yazoo	0
White River	756
Total	1,784

which is 819 square miles less than last year, the difference being principally in the Lower St. Francis district, where there were two crevasses in 1903, and where about 5 miles of levee have been placed in the gap between Cat Island and Bledsoe (252–268 R.).

THIRD DISTRICT (365 L. TO 607 R., 342 MILES).

Lower Yazoo levee district (365 to 592 L.)—(For description and previous history see Reports of the Mississippi River Commission since 1882.) (See map No. 32 herewith.) This district has a continuous levee line 187 miles long to Eagle Lake (584 L.). Its construction to the new mouth of the Yazoo River will involve an extension of about 14 miles, and when completed it will protect an area of 3,367 square miles.

At the beginning of the year, ten 1902–3 contracts were unfinished, and required 458,880 cubic yards for completion. Under allotment of $291,000 from the appropriation of March 3, 1903, eleven contracts for placing 1,370,000 cublic yards of new levee and enlargement had been made and 84,433 cubic yards placed.

During the year all 1902–3 contracts were completed except two at Jenkins Loop (434 L.), which require 24,945 cubic yards to complete, and all the 1903–4 contracts were completed excepting that at stations 100–200 (480 L.), which needs 10,070 cubic yards to complete, and at stations 1840–2070 and 2130–2230, which require

125,730 cubic yards to complete, and on which work was suspended at the request of the district engineer to enable contractor to close the Albemarle crevasse (568 L.). The banquette contract, stations 1346–1730 (500 L.), has been terminated by mutual consent after 64,695 cubic yards had been placed, there being a question involving the possible abandonment of this levee on account of caving bank, and the contractor having withdrawn at the request of the district engineer to enable him to undertake more urgent work.

Additional contracts during the year were let as follows: La Grange crevasse loop (480 L.), 270,000 cubic yards, at 15.74 cents, and Albemarle crevasse loop (569 L.), 90,000 cubic yards at 21.5 cents, both of which have been completed. Minor contracts for repair work and weed cutting were also made and completed.

Summary of earth in place.

			Cu. yds.
In place April 30, 1903			33, 263, 691
Added by the United States	1, 905, 843		
Added by levee board	1, 738, 266		
		3, 644, 108	
Lost and abandoned		1, 292, 413	
			2, 351, 695
In place April 30, 1904			35, 615, 386

Under allotment of $100,000 from the appropriation of April 28, 1904, for the fiscal year 1904–5, bids were opened April 13 for 412,000 cubic yards of enlargement and topping, and the lowest bid, of 18.9 cents, by M. J. Roach & Co., was accepted, and contracts have been made and approved. The 1904–5 allotment was originally $150,000, but at the request of the levee board $50,000 was later transferred to an allotment for a new revetment at Longwood, Miss., to be built during the coming season for the protection of the levee at that place, a careful study of the situation having developed the fact that the protection of the present levee by revetment would amount to about one-third of the cost of a new loop.

During the year the local levee board has built 1,738,266 cubic yards. They now have under contract 3,074,134 cubic yards additional, and they have advertised for bids on about 1,000,000 cubic yards more, which will exhaust their available funds for the coming year. During the past winter this levee board was authorized by the Mississippi legislature to make an additional bond issue of $1,000,000, which, with the portion of the revenue available for levee construction work, will provide funds for the work under contract and advertisement.

Required to complete to commission grade and section, about 13,000,000 cubic yards, at an estimated cost of $2,500,000. (For details see report of Asst. Engineer A. Miller Todd, Appendix 2 M, herewith.)

Upper Tensas levee district (*402 to 606 R.*).—(For description and previous history see reports of the Mississippi River Commission since 1882.) (See Map No. 32 herewith.) This district extends from Arkansas River to a point in Louisiana opposite Warrenton, Miss., and includes about 14.8 miles of Arkansas River levee below Red Fork, and about 172 miles of continuous Mississippi River levee in Arkansas and Louisiana, a total of 186.8 miles. The Arkansas River levee is incomplete and requires an extension of about 6 miles to Cypress Creek (426 R.).

At the beginning of the year three 1902–3 contracts, aggregating 316,000 cubic yards, were unfinished, requiring 129,000 cubic yards additional for completion. Under an allotment of $112,500 from the appropriation of March 3, 1903, four contracts for placing 516,000 cubic yards had been made, and 49,592 cubic yards had been placed. All of these contracts were completed during the year.

Two additional contracts were made during the year, both with Dulaney & Leonard: One, the Leland Neck spur, 60,000 cubic yards, and the other, stations 2170–2185, 30,000 cubic yards, both completed during the year.

Summary of earth in place.

			Cu. yds.
In place April 30, 1903			29, 092, 868
Added during year by the United States	677, 090		
Added during year by the levee boards	1, 808, 210		
		2, 485, 300	
Lost and abandoned		794, 042	
			1, 691, 258
In place April 30, 1904			30,784,126

Required to complete to Commission grade and section, 19,000,000 cubic yards; estimated cost, $3,500,000.

Under an allotment of $230,000 from the appropriation of April 28, 1904, for the fiscal year 1904–5, proposals were opened April 13, 1904, for 900,000 cubic yards of new and enlargement work, on which bids have been accepted and contracts prepared and forwarded for approval.

During the year the levee boards have placed 1,808,210 cubic yards of enlargement and new work, as follows:

		Cu. yds.
Arkansas boards—		
Red Fork		0
Desha County		16,738
Chicot County		10,000
		26,738
Louisiana boards—		
Tensas Basin	[a]290,499	
Fifth Louisiana	1,490,973	
		1,781,472
		1,808,210

(For details, see report of Asst. Engineer E. C. Tollinger, Appendix 2 N, herewith.)

CAVING BANKS, THIRD DISTRICT.

During the year the development of caving banks in this district has been unusually large, both as to number and extent, especially on the Mississippi side. At Australia (370 L.), Island 92 (527 L.), and Shiloh (555 L.) the caving bank is so near the levee that the levee board will, during the coming season, build new loops aggregating nearly 4,000,000 cubic yards. At Longwood (500 L.) caving is very active and dangerously close to the levee, and the United States will construct a revetment for its protection, at a cost of about $150,000, to avoid the expenditure of approximately $600,000 for a new loop. The United States will also build a new loop at Albemarle (570 L.) to contain about 600,000 cubic yards. At Shipland (545 L.) the caving was so rapid that the levee board deemed it necessary in December last to make an emergency contract for 360,000 cubic yards, to be completed by March 1. This cost 27 cents per cubic yard, although under ordinary conditions 18 cents would have been a fair price. Below Greenville (478 L.) active caving has recently set in and will, it is feared, necessitate a new loop within the next few years.

In the Upper Tensas district more or less active caving has been in progress, as follows: For 6 miles below Lucca Landing (427 R.) the levee is about 200 feet from bank in two places, and a new loop may be necessary this year; at Panther Forest (451 R.) a new loop may be needed in two years; at Mathews Bend (509 R.) a new loop may be needed in two years; at Biggs and Reid (604 R.), where very heavy caving necessitated in December last an emergency loop by the levee board of about 140,000 cubic yards, costing about 32 cents per cubic yard, which will be totally useless hereafter. To meet present necessities a Government contract has been prepared for 480,000 cubic yards of new work, which will be necessary to avoid a break within the next year, and this new loop will have to be extended within the next two or three years as the heavy caving progresses downstream.

HIGH-WATER OPERATIONS, THIRD DISTRICT.

By the time the April overflow reached the third district it was materially reduced in height and was nowhere less than 5 feet from the top of the levee.

In the Lower Yazoo district the necessary patrol work to guard against wave wash and protect the ends of spur dikes was undertaken by the levee board.

During this high water an unexpected cave, over 100 feet deep, occurred at Baleshed (537 L.), cutting into the levee as far as the intersection of the land slope with the crown of the banquette. The breach in the main levee was 120 feet wide, but fortunately a large levee outfit was on the ground engaged in constructing a new loop, and sufficient force was immediately put at work on an emergency loop, which was completed before the river rose above the top of the banquette. While the bank at this place has been slowly caving for many years, a cave of such magnitude was entirely unexpected. It illustrates the danger of leaving levees so close to the bank, even when the rate of caving is very small.

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[a] The work done by the Tensas Basin levee board of Louisiana was entirely in Arkansas.

In the Upper Tensas district the Government undertook the defense of the levees throughout Arkansas, and, at the request of the Fifth Louisiana levee board, from the State line to Station 1986 (about 37 miles) in Louisiana. The plan adopted was similar to that in the First and Second districts, but, for lack of practice, the organization was not as quickly placed in the field. Results, however, were satisfactory, and will be better another season.

	Sq. miles.
Area overflowed in Lower Yazoo district	520
Area overflowed in Upper Tensas district	50
Total (principally back water)	570
Area overflowed, 1903	2,635
Difference	2,065

GENERAL REMARKS ON LEVEE WORK.

For the first, second, and third districts the general situation as to levees has been much improved during the year.

The working season lasted until March, and at its close almost all weak places developed by the high water of 1903 had been materially strengthened, although to obtain the necessary grade many miles of topping had been placed where enlargement was, and still is, needed. A very large part of the available funds has been devoted to new loops, made necessary by caving banks. This is especially true of the Lower Yazoo district, where practically all of the $1,000,000 bond issue recently authorized by the Mississippi legislature has been so used, and over $100,000 of the 1905–6 Government allotment for that district will be similarly spent. This has prevented much raising of grades, which is still very necessary.

In the Upper St. Francis and Reelfoot districts the extensions of the levee systems have progressed steadily, if slowly; but in the former district the levee board is showing a disposition to participate in the work to a relatively large extent. This board has to maintain, unaided, the levee from Cairo north to Commerce, Mo., but during the past year it has spent $7,500 for a culvert at Brewer Lake, and for the present season has already contracted for more yardage below Cairo than will be done by the United States, and before the season is over will probably contract for as much more.

In the Lower St. Francis district the Arkansas levee board has been very active, having done considerable enlargement, closed two crevasses, and contracted to close the 18-mile gap from Cat Island to Bledsoe, which is now about one-third finished.

The Upper Yazoo district, the richest north of Vicksburg, has continued its very effective work and has the best levee in the territory under my supervision.

The White River district struggles along, but because of the poverty of the local boards has to depend largely on the United States for necessary additions to its levee system, although the Laconia board will make a considerable contribution this season. The White River levees are the lowest and weakest in my territory, and still have four of the 1897 crevasses open. Because of the necessities of this district the revised project of May 27, 1903, adopted the policy of substituting topping for enlargement wherever there is sufficient width of crown, and this policy must be followed for some time to come in order to obtain the absolutely necessary grade. The controlling idea is to conduct high-water defense under favorable conditions, and topping in dry weather at 20 cents per yard is far cheaper and more effective than sandbagging at perhaps $1.50 per yard during an overflow.

In the Lower Yazoo district the levee board has undertaken a very large amount of work, but unfortunately most of the available funds must go to build loops made necessary by caving banks. Nine hundred and seventy-four thousand cubic yards of enlargement and topping will still be badly needed for the lower part of this district after all available funds for 1904–5 have been utilized, and only 100,000 cubic yards of this can be cared for by the 1905–6 allotment, on account of the necessity for the Albemarle loop. This levee board is heavily handicapped by the excessive damages claimed and awarded on account of drainage of land thrown out and for occupation of land needed for new levees and borrow pits. I am informed that it is not unusual for owners of land assessed for taxation at about one dollar per acre to claim damages of $20 and upward per acre. This item of damages takes a considerable part of the board's annual income.

In the Upper Tensas district the Red Fork levee board contributed nothing to the strengthening or extension of the levee under United States supervision, their limited funds being applied to the Arkansas River levees north of Red Fork. The Desha and Chicot boards have small incomes and have placed only 26,738 cubic yards. The Tensas Basin board of Louisiana provided funds for 290,499 cubic yards in Arkansas, while the Fifth Louisiana levee board placed with their own funds and with funds contributed by the State 1,490,973 cubic yards in the Louisiana part of this district. The jurisdiction of the Fifth Louisiana board extends also over the Lower Tensas levee district, where the necessities are very great.

The following table shows, for the first, second, and third districts, the cubic yards in place, the yardage required to complete to Commission grade and section, the percentage of completed levee placed by the United States and by levee boards, etc., and the percentage of incomplete levee:

Levee district.	Cubic yards in place.	Cubic yards required to complete.	Percentage in place.		Percentage to complete.
			By United States.	By levee boards.	
Upper St. Francis	661,002	4,500,000	7.3	5.5	87.2
Reelfoot	789,131	1,300,000	12.1	25.7	62.2
Lower St. Francis	15,249,972	8,800,000	21.7	41.8	36.5
Upper Yazoo	22,090,622	5,100,000	24.3	58.7	18.0
White River	8,311,715	8,100,000	40.7	10.0	49.3
Lower Yazoo	35,615,386	13,000,000	33.0	40.4	26.6
Upper Tensas	30,784,126	19,000,000	37.1	24.7	38.2
Total	113,501,954	59,800,000			

This shows about 113,500,000 cubic yards in place and about 60,000,000 cubic yards needed to complete to Commission grade and section, the estimated cost of which will be about $12,000,000.

This estimate will be increased when the Commission adopts the new grades, the necessity for which was shown during the overflow of last year.

In the territory under the supervision of this office there are 15 levee boards, of which only 5 have an engineering organization. The remaining 10 are the minor boards with limited incomes and are unable to keep up any engineering organization, and usually request that work done by them shall be under the supervision of this office. There is no present authority for paying such engineering expenses from Government appropriations, and it is recommended that district officers be authorized to furnish engineering supervision and inspection without cost to the levee boards whenever requested, as in this way the levee boards will be sure that every dollar contributed by them will be applied to actual construction work. In my judgment the effect of such action will be to encourage the levee boards to raise funds.

The only change in methods of levee construction has been the introduction of the steam traction engine for hauling elevating graders. This method effects no noticeable saving in cost of construction, but it has the advantage of lessening the amount of labor required, the labor supply being very limited. The experience in the three districts shows, however, that the machine as now constructed often breaks down and is difficult to repair. Until furnished in more effective form it can apparently be used advantageously only on work of sufficient magnitude to warrant the employment of a reserve engine ready at all times to replace one broken down. A steam shovel has been placed on one of the large contracts just started by the levee board in the Upper Yazoo district, but its value and effectiveness have not yet been determined.

The overflow of April, 1904, was small as compared with that of last year, and involved relatively small expense for levee protection and did no material damage. The only real danger from crevasses and overtopping was in the Lower St. Francis district, between Luxora and West Memphis, Ark. A notable incident of this flood, however, was the unexpected caving at Baleshed, where the levee has been under observation for several years on account of the very slow caving and the nearness of the levee to the bank. This cave was 100 feet deep and cut through the main levee to the banquette. A crevasse was prevented only because there happened to be a large levee outfit in the vicinity which promptly constructed an emergency loop before the flood level rose above the top of the banquette. This illustrates the danger of a levee close to even a slowly caving bank.

Section 3 of the river and harbor act approved April 28, 1904, authorizes work during the coming fiscal year, to be paid for from the appropriation for the fiscal year 1905-6, and in accordance with your instructions, projects for the full allotments for the Upper St. Francis and Reelfoot districts and for 75 per cent of the allotments for the Lower St. Francis and Lower Yazoo districts were submitted. Projects for the Upper Yazoo, White River, and Upper Tensas districts can not properly be made until after an examination of the caving banks following the recession of the recent high water.

The systematic maintenance of levees must hereafter receive much more attention than has heretofore been the case. It is found that in many localities the utmost carelessness in this respect prevails during the low-water season. Fences across the levees are common, and in many places buildings are located on the inner slopes, and the slopes and tops are used for cattle pens. The use of the levee as a roadway, common in many places, may, by destruction of sod and formation of dust to be later blown away, cause a lowering of grade of 6 inches or more annually. Recently a printed poster notice of sections 14 and 16 of the river and harbor act of March 3, 1899, has been prepared and distributed along the levees, and the effect is gradually becoming apparent. It is expected, however, that some time must elapse before all obstructions can be cleared from the levee, and the education of the residents along the levee to the necessities of the situation must necessarily require a longer period.

The experience of the engineers in the first, second, and third districts indicates that angles in levees should be abandoned and curves substituted. Wherever during an overflow a strong current flows parallel to the levee, an angle creates an eddy which often causes serious damage below. In some cases the substitution of curves for angles has been made, with satisfactory results.

It is also believed that in the consideration of proposed new loops due to caving banks, the bank survey should be accompanied by a subaqueous survey, as very often valuable information can be obtained from consideration of the channel movement.

SURVEYS FIRST, SECOND, AND THIRD DISTRICTS.

The regular surveys of bank revetments and caving bends have been made, and additional surveys of reaches below La Grange and Hollybrook crevasses and above Delta Point were made.

(For details see report of Asst. Engineer Chas. Le Vasseur, Appendix 2 O, for first and second districts, and report of Junior Engineer L. Y. Kerr, Appendix 2 P, for third district.)

INCLOSURES.

The following inclosures accompany this report, of which they are parts:

Appendix 2 A.—Report of Asst. Engineer A. J. Nolty on channel work in first district.

Appendix 2 B.—Report of Asst. Engineer W. M. Rees on channel work in second district.

Appendix 2 C.—Report of Asst. Engineer A. J. Nolty on plant, first and second districts.

Appendix 2 D.—Report of Asst. Engineer Arthur Hider on channel work and plant, third district.

Appendix 2 E.—Report of Asst. Engineer Chas. Le Vasseur on levees, Upper St. Francis district.

Appendix 2 F.—Report of Asst. Engineer Chas. Le Vasseur on levees, Reelfoot district.

Appendix 2 G.—Report of Asst. Engineer A. F. Kilpatrick on levees, Lower St. Francis district.

Appendix 2 H.—Report of Asst. Engineer Chas. Le Vasseur on training wall, Lower St. Francis district.

Appendix 2 I.—Report of Asst. Engineer M. Gardner on levees, Upper Yazoo district.

Appendix 2 J.—Report of Asst. Engineer M. Gardner on levees, White River district.

Appendix 2 K.—Report of Asst. Engineer A. J. Nolty on high-water operations, Lower St. Francis district.

Appendix 2 L.—Report of Asst. Engineer Chas. Le Vasseur on caving banks, first and second districts.

Appendix 2 M.—Report of Asst. Engineer A. Miller Todd on levees, Lower Yazoo district.

Appendix 2 N.—Report of Asst. Engineer E. C. Tollinger on levees, Upper Tensas district.

Appendix 2 O.—Report of Asst. Engineer Chas. Le Vasseur on surveys, first and second districts.

Appendix 2 P.—Report of Jr. Engineer L. Y. Kerr on surveys, third district.
Map No. 1.—Columbus, Ky., revetment.
Map No. 2.—Hickman, Ky., revetment.
Map No. 3.—New Madrid, Mo., revetment.
Map No. 4.—Caruthersville, Mo., revetment.
Map No. 5.—Plum Point Reach.
Map No. 6.—O'Donnels Bend revetment.
Map No. 7.—Ashport Bend revetment.
Map No. 8.—Fletchers Bend revetment.
Map No. 9.—Upper Osceola bar revetment.
Map No. 10.—Lower Osceola and Bullerton bars revetment.
Map No. 11.—Abattis dikes, Hathaways Crossing.
Map No. 12.—Memphis Reach.
Map No. 13.—Hopefield Bend revetment.
Map No. 14.—Memphis Harbor revetment.
Map No. 15.—Helena front revetment.
Map No. 16.—Borings at Helena.
Map No. 17.—Helena Reach.
Map No. 18
Map No. 19 }Levees, first and second districts.
Map No. 20
Map No. 21
Map No. 22.—Overflowed area, first and second districts.
Map No. 23.—Drainage, Upper St. Francis district.
Maps 24 to 29.—Plans of Brewer Lake culvert.
Maps 30 and 31.—Plans of training wall, Lower St. Francis district.
Map No. 32.—Index map, third district.
Map No. 33.—Lake Bolivar revetment.
Map No. 34.—Ashbrook Neck revetment.
Map No. 35.—Greenville Harbor revetment.
Map No. 36.—Lake Providence revetment.
Map No. 37.—Lake Providence reach.
Map No. 38.—Delta Point revetment.
Map No. 39.—Delta Point reach.
Map No. 40.—Reach below Greenville.
Map No. 41.—Kentucky Bend.
Map No. 42.—Reach below Hollybrook crevasse.
Map No. 43.—Overflowed area, third district.
Map No. 44.—High-water slope, Lower Yazoo district.
Maps 45 and 46.—High-water slope, Upper Tensas district.

Money statements, abstract of contracts in force, abstracts of proposals, and list of civilian engineers will be forwarded July 1.

Respectfully submitted.

E. W. Van C. Lucas,
Captain, Corps of Engineers.

Col. O. H. Ernst,
Corps of Engineers, U. S. Army,
President Mississippi River Commission.

FINANCIAL STATEMENT.

Appropriation for improving Mississippi River, first and second districts.

HICKMAN, KY.

July 1, 1903, balance unexpended	$804.13
July 1, 1904, balance unexpended	804.13
July 1, 1904, balance available	804.13

NEW MADRID, MO.

July 1, 1903, balance unexpended	1,790.91
June 30, 1904, amount expended during fiscal year	103.80
July 1, 1904, balance unexpended	1,687.11
July 1, 1904, balance available	1,687.11
Amount that can be profitably expended during fiscal year ending June 30, 1906	20,000.00

CARUTHERSVILLE, MO.

July 1, 1903, balance unexpended	$388.20
June 30, 1904, amount expended during fiscal year	209.22
July 1, 1904, balance unexpended	178.98
July 1, 1904, balance available	178.98
Amount that can be profitably expended during fiscal year ending June 30, 1906	50,000.00

PLUM POINT REACH.

July 1, 1903, balance unexpended	2,778.00
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	69,000.00
	71,778.00
June 30, 1904, amount expended during fiscal year	71,431.01
July 1, 1904, balance unexpended	346.99
July 1, 1904, outstanding liabilities	346.99
Amount that can be profitably expended during fiscal year ending June 30, 1906	100,000.00

HOPEFIELD BEND.

July 1, 1903, balance unexpended	2,307.93
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	99,000.00
November 19, 1903, amount refunded on account error in voucher 79, September, 1903	1.00
	101,308.93
June 30, 1904, amount expended during fiscal year	101,251.04
July 1, 1904, balance unexpended	57.89
July 1, 1904, outstanding liabilities	57.89
Amount that can be profitably expended during fiscal year ending June 30, 1906	50,000.00

MEMPHIS, TENN.

July 1, 1903, balance unexpended	377.90
July 1, 1904, balance unexpended	377.90
July 1, 1904, balance available	377.90

MEMPHIS, TENN. (WOLF RIVER).

July 1, 1903, balance unexpended	3,727.55
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	8,000.00
Total	11,727.55
June 30, 1904, amount expended during fiscal year	7,812.96
July 1, 1904, balance unexpended	3,914.59
July 1, 1904, balance available	3,914.59
Amount that can be profitably expended in fiscal year ending June 30, 1906	25,000.00

HELENA, ARK.

July 1, 1903, balance unexpended	$1,783.40
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	5,000.00
Total	6,783.40
June 30, 1904, amount expended during fiscal year	6,436.74
July 1, 1904, balance unexpended	346.66
July 1, 1904, balance available	346.66
Amount that can be profitably expended in fiscal year ending June 30, 1906	25,000.00

DIKES.

July 1, 1903, balance unexpended	1,114.50
June 30, 1904, amount expended during fiscal year	1,114.50
Amount that can be profitably expended in fiscal year ending June 30, 1906	30,000.00

UPPER ST. FRANCIS LEVEE DISTRICT.

Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	20,000.00
June 30, 1904, amount expended during fiscal year	19,008.51
July 1, 1904, balance unexpended	991.49
July 1, 1904, outstanding liabilities	991.49
Amount that can be profitably expended in fiscal year ending June 30, 1906	200,000.00

LOWER ST. FRANCIS LEVEE DISTRICT.

July 1, 1903, balance unexpended	53,652.52
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	125,000.00
	178,652.52
Amount refunded on account of overpayment in vouchers 37 and 38, April, 1903	45.60
	178,698.12
June 30, 1904, amount expended during fiscal year	128,981.23
July 1, 1904, balance unexpended	49,716.89
July 1, 1904, outstanding liabilities	39,591.14
July 1, 1904, balance available	10,125.75
Amount that can be profitably expended in fiscal year ending June 30, 1906	500,000.00

WHITE RIVER LEVEE DISTRICT.

July 1, 1903, balance unexpended	37,837.95
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	90,000.00
	127,837.95
June 30, 1904, amount expended during fiscal year	111,814.63
July 1, 1904, balance unexpended	16,023.32
July 1, 1904, outstanding liabilities	300.00
July 1, 1904, balance available	15,723.32
Amount that can be profitably expended in fiscal year ending June 30, 1906	500,000.00

UPPER YAZOO LEVEE DISTRICT.

July 1, 1903, balance unexpended	$44,361.85
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	70,000.00
	114,361.85
June 30, 1904, amount expended during fiscal year	68,209.61
July 1, 1904, balance unexpended	46,152.24
July 1, 1904, outstanding liabilities	44,467.23
July 1, 1904, balance available	1,685.01
Amount that can be profitably expended in fiscal year ending June 30, 1906	200,000.00

REELFOOT LEVEE DISTRICT.

July 1, 1903, balance unexpended	1,858.71
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	20,000.00
	21,858.71
June 30, 1904, amount expended during fiscal year	20,621.68
July 1, 1904, balance unexpended	1,237.03
July 1, 1904, outstanding liabilities	500.00
July 1, 1904, balance available	737.03
Amount that can be profitably expended in fiscal year ending June 30, 1906	200,000.00

SURVEYS, FIRST AND SECOND DISTRICTS.

July 1, 1903, balance unexpended	$46.52
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	5,000.00
March 7, 1904, to error in voucher 4, January, 1904	.50
	5,047.02
June 30, 1904, amount expended during fiscal year	4,839.48
July 1, 1904, balance unexpended	207.54
July 1, 1904, outstanding liabilities	207.54
Amount that can be profitably expended in fiscal year ending June 30, 1906	10,000.00

PLANT, FIRST AND SECOND DISTRICTS.

July 1, 1903, balance unexpended		$26,085.78
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	$60,000.00	
December 18, 1903, amount received by transfer from third district, approved by Secretary of War, December 10, 1903	7,000.00	
April 11, 1904, amount received by transfer from third district approved by Secretary of War April 1, 1904	18,000.00	
May 9, 1904, amount allotted, being proceeds from sale of engineer property	260.00	
		85,260.00
		111,345.78
June 30, 1904, amount expended during fiscal year		108,935.53

July 1, 1904, balance unexpended	$2,410.25
July 1, 1904, outstanding liabilities	2,410.25
Amount that can be profitably expended in fiscal year ending June 30, 1906	75,000.00

Appropriation for repairing Government levee at Walnut Bend, Ark.

July 1, 1903, balance unexpended	$88,713.94
June 30, 1904, amount expended during fiscal year	3,724.22
July 1, 1904, balance unexpended	84,989.72
July 1, 1904, outstanding liabilities	800.00
July 1, 1904, balance available	84,189.72

Miscellaneous.

October 30, 1903, amount received from sale of engineer property	$79.10
February 15, 1904, amount received from B. F. Dame for rent of island in Mississippi River, near Australia, Miss., for year ending February 24, 1905	1.00
April 27, 1904, amount received from sale of engineer property	260.00
	340.10
October 30, 1903, amount deposited to credit Treasurer United States on account sale of engineer property	79.10
February 15, 1904, amount deposited to credit Treasurer United States on account rent of island in Mississippi River, near Australia, Miss., for year ending February 24, 1905	1.00
April 27, 1904, amount deposited to credit of Treasurer United States on account sale of engineer property	260.00
	340.10

Statement showing total amount expended in first and second districts, improving Mississippi River, during the fiscal year ending June 30, 1904.

From appropriation for improving Mississippi River	$650,769.94
Less refundments	47.10
	650,722.84
From appropriation for repairing Government levee at Walmut Bend, Ark	3,724.22
	654,447.06

Appropriation for improving Mississippi River, third district.

ASHBROOK NECK.

July 1, 1903, balance unexpended		$1,095.76
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903		60,000.00
		61,095.76
Amounts transferred during fiscal year as follows:		
To fourth district	$10,000.00	
To plant, first and second districts	5,000.00	
To plant, third district	9,000.00	
June 30, 1904, amount expended during fiscal year	37,080.75	
		61,080.75
July 1, 1904, balance unexpended		15.01
July 1, 1904, outstanding liabilities		15.01
Amount that can be profitably expended in fiscal year ending June 30, 1906		50,000.00

GREENVILLE, MISS.

July 1, 1903, balance unexpended		$7,633.57
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903		25,000.00
		32,633.57
Amounts transferred during fiscal year as follows:		
To plant, first and second districts	$7,000.00	
To plant, third district	7,000.00	
June 30, 1904, amount expended during fiscal year	18,453.25	
		32,453.25
July 1, 1904, balance unexpended		180.32
July 1, 1904, outstanding liabilities		104.50
July 1, 1904, balance available		75.82
Amount that can be profitably expended during fiscal year ending June 30, 1906		50,000.00

LAKE PROVIDENCE REACH.

July 1, 1903, balance unexpended	297.46
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	25,000.00
	25,297.46
June 30, 1904, amount expended during fiscal year	25,258.71
July 1, 1904, balance unexpended	38.75
July 1, 1904, outstanding liabilities	38.75
Amount that can be profitably expended in fiscal year ending June 30, 1906	30,000.00

PLANT, THIRD DISTRICT.

July 1, 1903, balance unexpended	$39,114.52
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	77,000.00
April 11, 1904, amount allotted, being proceeds of sale of public property	1,350.00
Amount received by transfer from other allotments, third district, during fiscal year	50,900.00
	168,364.52
June 30, 1904, amount expended during fiscal year	134,919.33
July 1, 1904, balance unexpended	33,445.19
July 1, 1904, outstanding liabilities	4,000.00
July 1, 1904, balance available	29,445.19
July 1, 1904, amount covered by uncompleted contract	22,428.00
Amount that can be profitably expended in fiscal year ending June 30, 1906	60,000.00

GENERAL REPAIRS TO EXISTING WORKS.

July 3, 1903, balance unexpended		$9,059.65
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903		30,000.00
		39,059.65
November 24, 1903, amount transferred to fourth district	$20,000.00	
April 1, 1904, amount transferred to allotment for plant, third district	9,000.00	

June 30, 1904, amount expended during fiscal year, account different works, as follows:			
Ashbrook Neck	$416.67		
Lake Providence reach	8,727.62		
Lake Bolivar front	472.81		
Surveys, third district	442.55		
		$10,059.65	
			$39,059.65
Amount that can be profitably expended in fiscal year ending June 30, 1906			50,000.00

STONE, THIRD DISTRICT.

July 1, 1903, balance unexpended		$30,918.74
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903		20,000.00
		50,918.74
August 21, 1903, amount transferred to plant, third district	$25,900.00	
April 1, 1904, amount transferred to plant, first and second districts	13,000.00	
June 30, 1904, amount expended during fiscal year	10,250.48	
		49,150.48
July 1, 1904, balance unexpended		1,768.26
July 1, 1904, outstanding liabilities		100.00
July 1, 1904, balance available		1,668.26
Amount that can be profitably expended during fiscal year ending June 30, 1906		40,000.00

LOWER YAZOO LEVEE DISTRICT.

July 1, 1903, balance unexpended	125,903.51
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	291,000.00
	416,903.51
June 30, 1904, amount expended during fiscal year	371,916.43
July 1, 1904, balance unexpended	44,987.08
July 1, 1904, outstanding liabilities	1,500.00
July 1, 1904, balance available	43,487.08
July 1, 1904, amount covered by uncompleted contracts	40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1906	500,000.00

UPPER TENSAS LEVEE DISTRICT.

July 1, 1903, balance unexpended	51,012.62
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	112,500.00
	163,512.62
June 30, 1904, amount expended during fiscal year	146,275.72
July 1, 1904, balance unexpended	17,236.90
July 1, 1904, outstanding liabilities	2,600.00
July 1, 1904, balance available	14,636.90
Amount that can be profitably expended in fiscal year ending June 30, 1906	500,000.00

SURVEYS, THIRD DISTRICT.

July 1, 1903, balance unexpended	$673.83
Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1903	5,000.00
	5,673.83
June 30, 1904, amount expended during fiscal year	5,673.23
July 1, 1904, balance unexpended	.60
July 1, 1904, outstanding liabilities	.60
Amount that can be profitably expended in fiscal year ending June 30, 1906	5,000.00

Miscellaneous.

March 17, 1904, amount received from sale of engineer property	1,350.00
March 17, 1904, amount deposited to credit of Treasurer United States on account sale of engineer property	1,350.00

Statement showing total amount expended in third district, improving Mississippi River, during the fiscal year ending June 30, 1904.

From appropriation for improving Mississippi River	$759,887.55

Abstract of contracts in force June 30, 1904, in first and second districts, improving Mississippi River.

Names of contractors.	Amount and character of work.	Rate per cubic yard.	Date of approval.	Date of beginning work.	Date of expiration of contract.
	Levee work in Upper St. Francis levee district.	*Cents.*			
Shutt Improvement Company	Station [illegible] to [illegible], 90,000 cubic yards	19½	Apr. 25, 1903	Oct. 2, 1903	[a]Jan. 31, 1904
Ben Talley & Co.	Station [illegible] to [illegible], 120,000 cubic yards	11.40	June 10, 1904	June 1, 1904	Jan. 31, 1905
	Levee work in Lower St. Francis levee district.				
Shutt Improvement Company	Station $\frac{11}{0}$ to $\frac{15}{0}$, station [illegible] to [illegible], station [illegible] to [illegible], 500,000 cubic yards	15	Oct. 4, 1902	Oct. 1, 1902	[a]Jan. 31, 1903
Do	Station $\frac{15}{0}$ to $\frac{17}{0}$, 75,000 cubic yards	17	Apr. 25, 1903	Sept. 26, 1903	[a]Jan. 31, 1904
Walker Stansell	Station [illegible] to $\frac{134}{0}$, 235,000 cubic yards	16.94	Apr. 20, 1903	Jan. 18, 1904	Do.[a]
Welsh Bros	Point Pleasant, Mo., 86,000 cubic yards	13½	June 1, 1904	June 1, 1904	Jan. 31, 1905
S. M. Bush	Station [illegible] to [illegible], 130,000 cubic yards	13.75	June 7, 1904	....do	Do.
Ben Talley & Co.	Station [illegible] to $\frac{69}{0}$, 100,000 cubic yards Station $\frac{134}{0}$ to $\frac{139}{0}$, 155,000 cubic yards	17 15.74	....do	....do	Do.
A. Outzen & Co.	Station $\frac{69}{0}$ to $\frac{72}{0}$, 100,000 cubic yards Station $\frac{124}{0}$ to $\frac{126}{0}$, 124,000 cubic yards Station $\frac{126}{0}$ to [illegible], 36,000 cubic yards	17.45 16.45 14.20	June 1, 1904	....do	Do.
	Levee work in White River levee district.				
W. F. Barbour & Son	Station [illegible] to [illegible], 220,000 cubic yards	17.40	June 24, 1904	June 1, 1904	Jan. 31, 1905
	Levee work in Upper Yazoo levee district.				
Geo. H. Lowrance	Station [illegible] to [illegible], 850,000 cubic yards	18.87	Apr. 21, 1903	Aug. 26, 1903	[a]Jan. 31, 1904
Ben Talley & Co.	Station [illegible] to [illegible], 300,000 cubic yards	17.49	June 7, 1904	June 1, 1904	Jan. 31, 1905

[a] Time limit waived.

Abstracts of contracts in force June 30, 1904, in third district, improving Mississippi River.

Names of contractors.	Kind of work and quantity.	Rate.	Date of approval.	Date of beginning work.	Date of expiration of contract.
Ed. J. Howard	Towboat and outfit	$53,900	Mar. 18, 1903	June 8, 1903	[a]Oct. 23, 1903
	Levee work in Lower Yazoo levee district.				
M. J. Roach & Co	Stations 3189 to 3229, 150,000 cubic yards	$19\frac{7}{10}$ cents per cubic yard	Sept. 19, 1902	Sept. 10, 1902	[a]Feb. 1, 1903
Do	Stations 3229 to 3245 + 42[a], 142,000 cubic yards	do	do	Oct. 1, 1902	Do.[a]
Lowrance Bros	Stations 1840 to 2070, 160,000 cubic yards	18 cents per cubic yard	May 23, 1903	Aug. 13, 1903	[a]Feb. 1, 1904
Do	Stations 2130 to 2230, 68,674 cubic yards	$17\frac{8}{10}$ cents per cupic yard	May 25, 1903	Aug. 5, 1903	Do.[a]
Walker Stansell	Stations 100 to 200, 30,000 cubic yards	$15\frac{74}{100}$ cents per cubic yard	June 19, 1903	Feb. 15, 1904	Do.[a]
M. J. Roach & Co	Stations 32 to 100, 200 to 550, 550 to 600, 112,000 cubic yards	$18\frac{8}{10}$ cents per cubic yard	May 26, 1904	June 1, 1904	Jan. 31, 1905
Do	Stations 940 to 1000, 1000 to 1100, 180,000 cubic yards	do	do	do	Do.
Do	Stations 1100 to 1200, 1200 to 1370, 120,000 cubic yards	do	do	do	Do.
	Levee work in Upper Tensas levee district.				
Ben Talley & Co	Stations 2580 to 3760, 3760 to 3950, 230,000 cubic yards	20 cents per cubic yard	June 7, 1904	June 1, 1904	Jan. 31, 1905
Do	Stations 1539 to 1810, 100,000 cubic yards	$18\frac{1}{4}$ cents per cubic yard			
H. Dalhoff	Stations 4459 to 4549, 480,000 cubic yards	$21\frac{8}{10}$ cents per cubic yard	June 24, 1904	do	Do.

[a] Time limit waved.

APPENDIX 2 A.

REPORT OF MR. A. J. NOLTY, ASSISTANT ENGINEER, ON CONSTRUCTION WORK IN FIRST DISTRICT DURING SEASON OF 1903–4.

MEMPHIS, TENN., *May 1, 1904.*

CAPTAIN: I have the honor to submit my report of construction works under my charge in the First district for the season of 1903–4.

No mention is made in the body of this report of the work done at Hopefield Bend by the First district organization, as that will appear in the report of Asst. Engineer W. M. Rees.

ABATTIS DIKES.

Island 14.—An abattis dike, 1,810 feet long, was placed here in 1902. A subsequent low-water examination disclosed a gap over 200 feet wide located about 700 feet from the river end. It is presumed that the section originally placed here was too lightly ballasted, and that when it was entirely submerged it became sufficiently buoyant to be easily displaced by the pressure of the current. This is the only instance, in the many thousand feet of dike built, where a section was lost. The gap was closed in January. All the remainder of dike was in good condition and much of it well silted up. A high bar was built up both above and below the dike, separated, however, by the flow through the gap, making virtually two large bars.

Summary of work done during the season of 1903–4.

Section No. 1 abattis dikes	feet	125 by 23
Section No. 2 abattis dikes	do	116 by 22
Brush cut	cords	97
Poles cut	do	16

Field cost of work.

Labor, including subsistence	$821.08
Stone, 110 cubic yards at $1.60	176.00
Lumber, 6,000 feet B. M. at $12.90 per M	77.40
Wire strand, ⅜ inch, 70 pounds, at 2.39 cents	1.67
Wire strand, ¼ inch, 100 pounds, at 4.5 cents	4.50
Wire, No. 12, 360 pounds, at 2.68 cents	9.64
Spikes, 50 pounds, at 2.85 cents	1.43
Nails, 35 pounds at, 2.75 cents	.96
Bolts, 120, at 6¾ cents	8.10
Coal, 230 bushels, at 13½ cents	31.05
Total cost	1,131.83

PLUM POINT REACH.

Daniels Point.—Two small faults having developed at the lower end of the 1895 revetment, they were repaired during this season. These faults were in the shape of two contiguous "pockets," and were treated as one. Repairs consisted in placing three connecting mats, aggregating 208 squares; 339 linear feet of bank was graded and 246 linear feet paved. A slight rupture at and below the low-water line was repaired by carefully distributing 69 cubic yards of spalls and riprap. A washout above the upper edge of the paving was checked by placing two small brush and stone cribs across. An attack at the lower end of the salient which divides the 1895 and the older work below was checked by first placing a connecting mat and then building upon this a brush and stone reenforcement 100 feet long and containing 2,384 cubic yards.

Summary of work done during the season of 1903–4.

Pocket mat No. 1	feet	47 by 152
Pocket mat No. 2	do	54 by 133
Pocket mat No. 3	do	58 by 112
Pocket mat No. 4	do	50 by 121
Crib dike No. 1, 4.5 by 10 by 33 feet	cubic feet	1,485

Crib dike No. 2, 3.4 by 9 by 36 feet	cubic feet..	1,101
Crib dike No. 3, 16.5 by 13 by 100 feet	do....	21,451
Brush cut	cords..	44
Poles cut	do....	6
Bank paved	square yards..	332

Field cost of work.

Labor, including superintendence and subsistence	$2,192.69
Brush, 516.2 cords, at $1.09	562.66
Stone, 582 cubic yards, at $1.60	931.20
Wire, No. 12, 1,810 pounds, at 2.68 cents	48.50
Wire strand, 5/16 inch, 852 pounds, at 3.5 cents	29.82
Wire strand, 1/4 inch, 1,425 pounds, at 4.5 cents	64.12
Wire strand, 1/2 inch, 30 pounds, at 3.55 cents	1.06
Clips, 225, at 6 3/4 cents	15.19
Staples, 67 pounds, at 2.9 cents	1.94
Coal, 125 bushels, at 13 1/2 cents	16.87
Towing	416.60
Rope	100.00
Miscellaneous materials, iron, oils, etc	34.84
Total cost	4,415.49

Ashport Bend.—After the decline of the flood of 1903 it was noticed that the lower one-third of the length of this revetment was badly eroded between the upper edge of the paving and the crest of the bank. At some places the scour was considerably below the upper elevation of the riprap paving, while at others it simply scoured back on the same plane as the paving. To check any further erosion, as well as to fill up the depressions, 10 brush and stone cribs were placed, not at regular intervals, but at such places as was thought best to attain the desired results. The repair of the large "pocket" caved out in 1902, and whose repair was interrupted that season by the early advent of high water in 1903, was completed. As an additional preventive against further scour above the paving a method, the object of which is to induce a growth of willows, was applied. Willows from 3 to 6 inches diameter at the butt were placed in shallow trenches normal to the bank line and 15 feet apart and lightly covered with soil. A few large stones were placed on each to prevent floating when submerged in case the soil should wash off. About eight years ago an attempt was made for a similar purpose by planting young willow sprouts, but failed, as the cattle would pull them up while feeding on the green tops. Should the method tried last year give good results it should be applied to all work where the paving is not carried to the top of the bank.

Summary of work done during the season of 1903-4.

Pocket mat	feet..	111 by 120
Bank paved	square yards..	264
Crib dike No. 1, 44 by 11 by 4 by 4.3 feet	cubic feet..	1,419
Crib dike No. 2, 71 by 11 by 4 by 4.5 feet	do....	2,393
Crib dike No. 3, 40 by 11 by 4 by 5.4 feet	do....	1,620
Crib dike No. 4, 43.5 by 15 by 4 by 5.9 feet	do....	2,438
Crib dike No. 5, 51 by 14 by 4 by 5.6 feet	do....	2,570
Crib dike No. 6, 52 by 15 by 4 by 6.2 feet	do....	3,062
Crib dike No. 7, 53 by 15 by 4 by 6 feet	do....	3,021
Crib dike No. 8, 35 by 10 by 4 by 4 feet	do....	980
Crib dike No. 9, 42.8 by 8 by 4 by 2.9 feet	do....	744
Crib dike No. 10, 51 by 13 by 4 by 4.4 feet	do....	1,907
Brush cut	cords..	70
Poles cut	do....	12
Willows planted (15 feet apart)	linear feet..	7,185

Field cost of work.

Labor, including superintendence and subsistence	$3,127.78
Brush, 430.5 cords, at $1.09	469.25
Stone, 340 cubic yards, at $1.60	544.00
Stone,[a] 350 cubic yards, at $1.64	574.00

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[a] Represents stone caved into the river and subsequently recovered, paid for in 1902.

Coal, 375 bushels, at 13½ cents	$50.62
Wire, No. 12, 750 pounds, at 2.68 cents	20.10
Towing	467.80
Rope	109.39
Miscellaneous materials, iron, oils, etc	66.05
Total cost	5,428.99

Fletchers Bend.—Repairs to damage in the old style (1889–1891) revetment of this bend were begun in 1902, but for lack of sufficient funds could not be completed. In the meantime the gradual destruction of the work continued both above and below the repairs of 1902, and at the opening of the working season there existed 700 feet of caving bank above and 1,800 feet below it. In addition to this there was considerable damage to the 1899 work in the pocket between the two salients. The river mat, as a thorough examination showed, was uninjured, the damage being caused by the settling away of the mat from the paving, aggravated by a strong return flow of seep water. The method of repairs consisted in placing large connecting mats, sufficiently wide to overlap the river mat, in front of the damaged bank, and then repaving the previously graded slope. The other repairs consisted in placing standard revetment with mats 250 feet wide. One mat was placed above and one below the 1902 work. This leaves about 1,800 feet of bank unrepaired, and these repairs, owing to the shortness of funds, had to be postponed. It is hoped that the work can be completed this season.

In 1902 there was stored on the bank behind the revetment 10,068 cubic yards of surplus stone. During and immediately after the flood of 1903 the bank began to cave rapidly, and before arrangements to save the stone could be perfected most of it had caved in. One thousand and sixty-seven cubic yards were loaded on barges, and 186 cubic yards were moved back and afterwards used on the work. The 1,067 cubic yards loaded on barges was used at Hopefield Bend. As the river declined toward a low-water stage, 884 cubic yards more were picked up from along the foot of the bank. There was saved 2,137 cubic yards, and lost 7,931 cubic yards.

Summary of repair work done during the season of 1903–4.

Connecting mat No. 1	feet	46 by 250
Connecting mat No. 2	do	88 by 250
Connecting mat No. 3	do	71¾ by 184
Connecting mat No. 4	do	50 by 85
Connecting mat No. 5	do	50 by 110
Crib dike No. 1, 103 by 2.9 by 10 feet	cubic feet	2,987
Crib dike No. 2, 36 by 4.2 by 9.5 feet	do	1,436.4
Crib dike No. 3, 28 by 5 by 8 feet	do	1,120
Bank paved	square yards	5,334
Hydraulic grading	cubic yards	23,525

Field cost of repair work.

Labor, including superintendence and subsistence	$4,658.13
Stone, 2,598 cubic yards, at $1.6344	4,247.45
Brush, 1,084 cords, at $1.09	1,181.56
Poles, 27 cords, at $2	54.00
Wire strand, 5/16 inch, 2,778 pounds, at 3. 3 cents	92.79
Wire strand, ¼ inch, 2,276 pounds, at 4.4382 cents	101.01
Wire, No. 12, 1,249 pounds, at 3.55 cents	33.47
Clips, 5/16 inch, 518, at 3½ cents	18.13
Staples, 125 pounds, at 2.9 cents	3.62
Coal, 398 bushels, at 13½ cents	53.73
Towing	1,291.07
Rope	107.50
Miscellaneous materials, oils, and supplies	50.50
Total cost	11,892.96

Summary of new work done during the season of 1903–4.

River mat No. 1	feet	705 by 250
River mat No. 2	do	778 by 250
Four connecting mats	feet	60 by 136, 32 by 83, 36 by 168, and 35 by 161
Bank paved	square yards	9,887
Hydraulic grading	cubic yards	40,041

Field cost of new work.

Labor, including superintendence and subsistence	$15,891.47
Stone, 6,303.1 cubic yards, at $1.6344	10,302.47
Brush, 5,998.4 cords, at $1.09	6,538.25
Poles, 211.6 cords, at $2	423.20
Hardwood poles	107.20
Wire strand, ⅜ inch, 8,867 pounds, at 2.39 cents	211.92
Wire strand, 5/16 inch, 10,790 pounds, at 3.34 cents	360.38
Wire strand, ¼ inch, 22,054 pounds, at 4.382 cents	978.80
Wire strand, ½ inch, 1,690 pounds, at 3.55 cents	59.99
Silicon bronze wire, 1,190 pounds, at 17.5 cents	208.25
Wire, No. 12, 8,634 pounds, at 2.68 cents	231.39
Clips, 5/16 inch, 2,845, at 3½ cents	99.72
Clips, ⅜ inch, 302, at 4½ cents	13.58
Clips, ½ inch, 121, at 6 cents	7.26
Staples, 680 pounds, at 2.9 cents	19.72
Lumber	88.65
Coal, 667 bushels, at 13½ cents	91.39
Towing	4,929.01
Rope	392.50
Miscellaneous materials, oils, and supplies	261.13
Total cost	41,216.28

Unit cost of new work.

River mat No. 1, 1,762.5 squares, at $7.94	$13,796.48	
River mat No. 2, 1,945 squares, at $7.57	14,735.02	
		$28,531.50
Connecting mats, 223.99 squares, at $13.84		3,114.30
Paving, 9,887 square yards, at $0.871		8,620.79
Grading, 40,041 cubic yards, at $0.0237		949.69
Total cost		41,216.28

Cost per linear foot of completed work, $27.79.

Recapitulation, Plum Point reach.

Repair work, Daniels Point	$4,415.49
Repair work, Ashport Bend	5,428.99
Repair work, Fletchers Bend	11,892.96
New work, Fletchers Bend	41,216.28
Total cost	62,953.72

Osceola bar.—Prior to the opening of the working season it had been the intention to continue and complete the repairs begun here in 1902. Available funds being inadequate to do much here and at Fletchers Bend also, and the repairs of the revetment at the latter place being considered more urgent, the district officer decided to expend the funds at Fletchers Bend, postponing the other work until the following season.

A late examination shows that this bend has now assumed a regular curvature, free from projecting points or deep scallops, making it an ideal one for revetment and for unrestrained flow along the bank. It is therefore very desirable that this work, as outlined in my project submitted to you recently, be done during the coming season.

Maps showing the work done during the season at the localities mentioned are submitted herewith; also abstracts of expenditures and summary of work done.

No recommendations for future work are made in this report, as these have been fully discussed in the paper submitted to you on March 7 of the current year.

Respectfully submitted.

Aug. J. Nolty, *Assistant Engineer.*

Capt. E. W. Van C. Lucas,
Corps of Engineers.

APPENDIX 2 B.

REPORT OF MR. W. M. REES, ASSISTANT ENGINEER, ON CONSTRUCTION WORK IN SECOND DISTRICT, DURING SEASON OF 1903-4.

MEMPHIS, TENN., *May 1, 1904.*

CAPTAIN: I have the honor to submit a report upon the construction works under my charge at Hopefield Bend, Arkansas, Wolf River, Tennessee, and Helena, Ark., for the season ending March 31, 1904.

HOPEFIELD BEND.

The river bank at this locality has been revetted at various times from 1882 to 1899, the revetment extending from Mound City Chute to Hopefield Bend, a length of about 16,600 feet.

Briefly, the upper 5,300 feet built in 1883 and 1884 was of lightly woven mattresses, 140 to 150 feet wide, covering the slope of the bank only part way to deep water, with a revetment above the low water built of brush works ballasted with stone, and extending to about the two-thirds bank-full stage. Below this was about 1,000 feet of similarly constructed revetment built in 1885, but with slightly wider mats, and the upper bank revetted with brush work to the top. This at its lower end joins a revetment built between 1887 and 1892, having channel mats of the diagonal woven type, a thicker construction than the preceding, and from 200 to 220 feet wide, and with the upper bank along it paved with stone to the top. This type of channel mat covers about 4,000 linear feet of the bank, below which the revetment is of fascine channel mats built in 1893 and 1899, having a length of 6,300 feet. The mats here are from 250 to 300 feet wide, and the bank above these is paved with stone to the top.

The 1883-84 revetment protected the bank for some years after its construction. Later, the current decreased here and finally the upstream half was covered with deposits.

During the high water of 1903, changes in the river threw the current strongly against the lower portion of this bank, and the old revetment, being much weakened by age and decay, offered practically no resistance to caving. When the flood waters receded it was found that the 1883-84 revetment had been destroyed from the head of the 1885 work upstream for a distance of about 2,800 feet; that there were two small breaks in the 1885 work and two of larger size in the 1891 work, about 800 feet below its head.

As the cavings at this locality were a serious menace to preserving the integrity of the harbor of Memphis, the Commission allotted the sum of $99,000 to repair the damages. Later developments showed this sum was entirely insufficient for the purpose, but it is believed that it was expended at such place where the best results in holding the bank will be attained.

During the entire working season the caving progressed, cutting back deeper into the bend and extending both up and down stream. The upstream extension has been 300 feet, and 400 feet of the upper end of the 1885 work has been lost, making the present total length of caving 3,500 feet, with a maximum width of 300 feet. The balance of the 1885 revetment is failing, and its entire loss is practically assured.

The breaks in the 1891 works, originally two pockets, 700 feet in extreme length, enlarged somewhat at the ends and the bank between the pockets caved in, forming practically one large pocket. The pockets were immediately below the wreck of a large steamer which lies on a point and under which is a strong eddy, to the action of which the failure is ascribed. The work done during the season consisted in revetting the bank from near the head of the caving downstream to a hard blue-clay point just above the 1885 revetment, this covering the most actively caving portion of the bank, and in revetting along the pockets of the 1891 work and making a number of minor repairs to this revetment at other places where it was beginning to fail.

The new revetment placed, i. e., that along the old 1883-84 work, covered a bank length of 2,718 linear feet, of which 2,558 linear feet was paved and may be considered as complete.

The revetment along the 1891 pockets was 840 feet long, and the aggregate length of repairs or reinforcements to other portions of the 1891 revetment was 1,280 feet.

CONSTRUCTION.

Channel mats.—The work of clearing the bank of timber was begun on August 15, and on September 1 the first floating plant was delivered and the construction of the first mattress was begun on the 4th. This mattress, which was 1,000 feet long by

254 feet wide, was sunk on the 26th, when the river was at the 12-foot stage. Owing to the strong current (over six feet per second) four additional steel mooring cables were attached to this mat, making twelve in all, and these were heavily strained when the mat was being sunk.

During the construction of this mattress the bank caved at the head almost continuously, destroying two sets of pile abutments and cutting back fully 60 feet of the bank. This left the mooring barges well out into the river; but before sinking, two small flats were placed between them and the bank, and with the aid of two large spars the thrust of the mooring barges was transferred to the bank.

Channel mat No. 2 was begun September 28 and sunk October 25. It was immediately below mat No. 1, was 1,130 by 254 feet, and sunk when the stage was 10½ feet, with surface velocity of 6¾ feet on the outside and nearly the same in the middle. This mat was moored with seven 1⅛-inch and three 1-inch cast steel wire ropes and three ½-inch wire strand on the inside portion, practically eleven fastenings in all. All were strained very heavily in sinking, and several of the 1-inch long links in the ¾-inch chain straps by which the wire ropes were connected with the mattress were broken, but fortunately not until the mattress was on the bottom. The bank, caving along this mat during time of construction, almost involved the abutment.

Channel mat No. 3 was begun November 7 and completed ready for sinking on November 25. It was just below mat No. 2, was 915 by 254 feet, well built and cabled, and moored to the bank with 12 steel wire ropes, some of which had been recently obtained for the purpose. All of the old chain straps, which were too light, had been replaced with stronger ones made of 1-inch dredge chains with 1¼-inch long links.

The river at the time of sinking, November 25, had fallen to the 6-foot stage, and the velocity of the current at the outside end of the mat was 6 feet per second and at the middle scant 5 feet. Although the condition of river stage and current were more favorable than when mat No. 2 was sunk, and the mattress was better moored, somewhat stronger built and considerably shorter, nevertheless most of it was lost in an attempt to sink. Prior to sinking, the mattress had been well ballasted and the shore edge from the head to about 500 feet below it rested on the graded slope for a width of about 8 feet, and this part was heavily paved. While the mat was being built a string of saw logs, probably several dozen, ran under it, lodging from 150 to 250 feet below the head and about 50 feet from the outer edge. When the mat head was lowered for placing the stone barges preparatory to sinking, a high wind blew the steamer on to the mat, where it fouled, remaining for over an hour before it could be liberated. After it was released the mat head was lowered to the bottom without any trouble and with no unusual strains on the mooring lines, and the sinking progressed as usual until fully two-thirds of the mattress was beneath the surface, when the mattress suddenly broke in two about 150 feet below its head, the mat here being practically on the bottom.

The cause of the breaking is ascribed principally to a large cave of the bank which occurred at this time just abreast of the line of rupture The large mass of sliding earth, weighing probably several thousand tons, striking the edge of the partly sunk mat, pushed it outstream and strained the outer cables to the breaking point. When these once had broken the mat tore in two like ripping a piece of cloth. Possibly the saw logs under the mattress and the fouling of the steamer on top, which, so far as known, broke two binder poles, may have added to the cause of the failure. The loss was 765 linear feet of mattress 254 feet wide, costing $11,359.42.

Channel mat No. 4 was then built, and sunk December 4. It laps the saved portion of No. 3 and extends downstream to a hard blue-clay point, where the season's work ends. This mat is of the longitudinal fascine type, 120 to 180 feet wide and 208 feet long.

A narrow channel mat, 116 feet wide by 840 feet long, was built and sunk January 9, 1904, across the pocket caves in the 1891 revetment.

Connecting mats.—Many of these were required, owing to the very irregular character of the shore lines along both new and old revetment. Nine of these were placed along the channel mats of the new work and two immediately above to prevent, if possible, the caving from extending back of the new work. Five connecting mats were required along the large pocket cave in the 1891 work, and two others sunk to make minor repairs. In all, 18 were placed, aggregating 1,656.3 squares.

The connecting mats were built with the same plant used for building channel mats, between the times of their construction and afterwards, the last work on them closing on February 15, 1904. All channel and connecting mats were of fascine construction.

Grading.—The bank was graded by the hydraulic method to a slope varying from 1 on 2½ to 1 on 3. The slope was not extended to the top of the bank, but a vertical bench left there about 6 feet in height. This was done to save time, the machine not being of sufficient capacity in such tenacious material to finish the slope to the top.

Grading on the new work was begun October 15, suspended from the 21st to 27th to await the sinking of a mattress, the lines from which were in the way, and finished January 7. Early in December one of the pump cylinders cracked, necessitating work under a reduced pressure afterwards, and for about ten days the pumps of the tug *Itasca* were used to assist in grading. From January 8 to 21 the bank along the 1891 pockets was graded. The total length of bank graded was 3,138 feet. Considerable hand grading was also done, principally along the 1891 pockets and at other places along the revetment of this year where the paving was broken or settled.

Paving.—This work was begun late in November and finished March 3. It was of the usual type, consisting of a closely pitched layer of stone 7 to 8 inches thick on a bed of quarry spalls 3 to 4 inches thick. The paving along the new work extends to stages varying from 20 to 27 feet on the Memphis gauge, and has a length of 2,558 feet. Along the 1891 pocket repairs it is carried up to the 20 and 21 foot stages. The height to which paving was carried was governed by the character of the soil, the object being to pave over all easily erodable strata ending on a hard clay above.

Considerable paving repairs were also made to the 1891 revetment. This had settled in places both at and above the low-water line. Some blocks of paving were removed and reconstructed, and at some places considerable stone was filled in below the low-water line to obtain a footing for the paving.

Material and labor.—Brush and poles were supplied by contract at $1.10 per cord for the former and $2 per cord for the latter, and except for a few days at the beginning of the work, the deliveries were good and up to the requirements.

Stone was supplied by contract at $1.70 per cubic yard f. o. b. Government barges at West Memphis. The stone was quarried at Williford and Black Rock, Ark., on the Frisco Railroad, and the same contractor had the contract for supplying stone to Plum Point reach. Only one small train load was shipped to the latter place when the railroad company, on account of the condition of their roadbed, refused to deliver more, and the major portion of the Plum Point supply was loaded on barges at West Memphis. The deliveries here were at no time up to the requirements of both works, due principally to the failure of the railroad company to promptly handle the quarry output, and the result was that the work, especially at Hopefield Bend, was long drawn out.

The labor supply in general was sufficient for the work, but not of very high efficiency. The price paid was $1.50 per day of eight hours, without subsistence, negroes being principally employed, though for some time a small force of white men was employed at $1 per day and subsistence.

In general.—The season as a whole was a rather unfavorable one, due, first, to the high stage of the river, which made mattress construction slow and expensive at a location where high currents prevailed, and, second, to the delay occasioned by the slow delivery of stone. Twice the entire floating plant was removed to get out of the way of running ice. At the close of the season 2,558 linear feet of revetment had been placed in renewal of the 1883–84 work, leaving a gap between it and the paved revetment of 1891 of 1,300 feet. Repairs, practically a renewal, had been made to 840 linear feet of the 1891 revetment, and the balance of this work had been repaired.

Future work requires the closure of the gap between the two revetments, the extension of the revetment upstream, as caving there necessitates it, and the probable reenforcement of the 1891 revetment with fascine mattresses to replace those of the old woven type. The amount of work done and cost is shown below.

Extent of work and cost in detail.

NEW WORK.

Four channel mats, containing 8,046.2 squares:

Brush (10,861 cords)	$11,917.25
Brush (165 cords, cut by labor)	187.50
Poles (496.6 cords)	993.20
Poles (35 cords, cut by labor)	69.50
Stone riprap (4,890.31 cubic yards)	8,249.50
Stone spalls (532.45 cubic yards)	905.16
¼-inch strand (47,567 pounds)	1,878.88
$\frac{5}{16}$-inch strand (22,815 pounds)	761.99
⅜-inch strand (15,860 pounds)	375.88

Four channel mats, containing 8,046.2 squares—Continued.		
½-inch strand (10,737 pounds)	$384.37	
No. 12 wire (17,340 pounds)	447.36	
Bronze wire (3,385 pounds)	592.37	
Wire staples (1,580 pounds)	46.89	
5/16-inch cable clips (7,334)	256.70	
⅜-inch cable clips (734)	38.42	
½-inch cable clips (975)	78.30	
Miscellaneous material	155.43	
Team hire	43.75	
Labor	18,932.75	
Subsistence services	408.66	
Subsistence stores	1,155.19	
Total cost, at $5.950 per square		$47,879.05
Eleven connecting mats containing 1,067 squares:		
Brush (1,278.2 cords)	1,404.09	
Poles (37 cords)	74.00	
Stone riprap (1,210 cubic yards)	2,057.00	
Stone spalls (60 cubic yards)	102.00	
¼-inch strand (5,922 pounds)	238.15	
5/16-inch strand (2,525 pounds)	84.49	
⅜-inch strand (408 pounds)	9.67	
No. 12 wire (3,353 pounds)	86.60	
Bronze wire (54 pounds)	9.45	
Wire staples (510 pounds)	15.23	
5/16-inch cable clips (1,283)	48.19	
⅜-inch cable clips (65)	3.15	
½-inch cable clips (11)	.78	
Labor	3,779.81	
Subsistence services	71.87	
Subsistence stores	140.10	
Total cost, at $7.614 per square		8,124.58
Clearing bank, 8.35 acres:		
Labor	487.82	
Subsistence services	1.06	
Subsistence stores	3.29	
Total cost, at $58.94 per acre		492.17
Hydraulic grading, 2,558 linear feet, 48,602 cubic yards:		
Labor	1,004.00	
Subsistence services	101.94	
Subsistence stores	272.36	
Coal	746.75	
Oil and engineers' supplies	26.74	
Total cost, at $0.841 per linear foot, or $0.0442 per cubic yard		2,151.79
Paving bank, 14,441 square yards:		
Stone riprap (2,990 cubic yards)	5,083.00	
Stone spalls (1,383 cubic yards)	2,351.10	
Labor	3,471.83	
Subsistence services	142.54	
Subsistence stores	236.27	
Total cost, at $0.781 per square yard		11,284.74
Crib dike 60 feet long, 8 feet maximum height, 3,262 cubic feet:		
Brush (45 cords)	49.50	
Stone riprap (40 cubic yards)	68.00	
No. 12 wire (200 pounds)	5.30	
Labor	115.34	
Total cost, at $0.073 per cubic foot		238.14
Total field cost of new work		70,170.47

REPAIRS TO LARGE POCKET CAVE IN 1891 REVETMENT—LENGTH OF WORK, 840 FEET.

Channel mat 840 by 116 feet, containing 974.4 squares:		
Brush (1,440.3 cords)	$1,569.92	
Poles (76.2 cords)	152.40	
Stone riprap (797 cubic yards)	1,354.90	
¼-inch strand (6,989 pounds)	314.50	
5/16-inch strand (2,783 pounds)	93.00	
⅜-inch strand (705 pounds)	16.71	
½-inch strand (663 pounds)	23.74	
No. 12 wire (2,972 pounds)	76.68	
Bronze wire (238 pounds)	41.65	
Wire staples (200 pounds)	6.00	
5/16-inch cable clips (686)	24.01	
⅜-inch cable clips (160)	10.86	
½-inch cable clips (29)	1.74	
Team hire	15.75	
Labor	2,319.16	
Subsistence services	82.05	
Subsistence stores	238.34	
Total cost, at $6.508 per square		$6,341.41
Five connecting mats, containing 478.3 squares:		
Brush (584.2 cords)	636.42	
Brush, cut by day labor (55 cords)	67.04	
Poles (32 cords)	64.00	
Stone riprap (452 cubic yards)	768.40	
¼-inch strand	139.38	
5/16-inch strand	38.26	
⅜-inch strand	6.40	
No. 12 wire	39.08	
Wire staples	3.15	
5/16-inch cable clips	27.18	
⅜-inch cable clips	2.40	
Labor	1,915.85	
Subsistence services	59.16	
Subsistence stores	120.67	
Total cost, at $8.127 per square		3,887.39
Hydraulic grading, 550 linear feet, 10,450 cubic yards:		
Labor	209.00	
Subsistence services	24.30	
Subsistence stores	71.95	
Coal	149.37	
Oil and engineers' supplies	5.50	
Total cost, at $0.836 per linear foot, $0.044 per cubic yard		460.12
Hand grading, 1,100 cubic yards:		
Labor, total cost, at $0.2364 per cubic yard		260.08
Paving bank, 4,375 square yards:		
Stone riprap (1,115 cubic yards)	1,895.50	
Stone spalls (294 cubic yards)	499.80	
Labor	1,379.84	
Subsistence services	167.79	
Subsistence stores	392.01	
Total cost, at $0.990 per square yard		4,334.94
Total field cost of repairs to 1891 pocket		15,283.94

MINOR REPAIRS TO 1891 REVETMENT.

Two connecting mats, containing 111 squares:		
Brush (160.9 cords)	$175.38	
Poles (10 cords)	20.00	
Stone riprap (147 cubic yards)	249.90	
¼-inch strand (815 pounds)	36.67	

Two connecting mats, containing 111 squares—Continued.		
5/16-inch strand (206 pounds)	$6.88	
No. 12 wire (224 pounds)	5.86	
Wire staples (30 pounds)	.90	
5/16-inch cable clips (127)	6.97	
3/8-inch cable clips (30)	1.88	
1/2-inch cable clips (4)	.24	
Labor	350.17	
Subsistence services	12.39	
Subsistence stores	36.84	
Total cost at $8.144 per square		$904.08
Hand grading, 1,100 cubic yards:		
Labor, total cost at $0.2364 per cubic yard		260.09
Paving bank, 1,800 square yards:		
Stone riprap (440 cubic yards)	$748.00	
Stone spalls (160 cubic yards)	272.00	
Labor	591.36	
Total cost at $0.8952 per square yard		1,611.36

MISCELLANEOUS REPAIRS.

Removing old mat works near low-water line, filling holes with stone and placing additional stone on old revetment:		
Stone spalls (400 cubic yards used from bank) labor cost	$503.32	
Stone riprap (402 cubic yards)	683.40	
Stone spalls (172 cubic yards)	292.40	
Labor	721.40	
		2,200.52
Total field cost minor repairs		4,976.05

GENERAL EXPENSES.

Superintendence:		
Labor	$1,216.83	
Subsistence services	131.63	
Subsistence stores	197.64	
		1,546.10
Care of plant:		
Labor	1,197.74	
Subsistence services	319.56	
Subsistence stores	438.78	
Coal	160.00	
Oil and engineers' supplies	22.83	
		2,138.91
Repairs to plant:		
Labor	300.00	
Subsistence services	17.35	
Subsistence stores	47.85	
		365.20
Towing:		
Labor	3,050.37	
Subsistence services	324.78	
Subsistence stores	978.61	
Coal	2,211.36	
Oil and engineers' supplies	204.68	
Miscellaneous material	45.00	
		6,814.80
Total of general expenses		10,865.01
Grand total cost of work		101,295.47

The general expense account of $10,865.01, for superintendence, towing, care of and repairs to plant, is about 10.73 per cent of the total cost, and prorating this into the various costs gives the total cost.

Summarizing the cost of work with reference to its locality we have:

For new work	$78,604.28
Repairs to 1891 pocket	17,118.01
Minor repairs	5,573.18
Total	101,295.47

Summarizing the cost of work with reference to its kind we have:

Cost of 9,020.6 squares channel mats (Cost per square, $6.72.)	$60,740.27
Cost of 1,656.3 squares connecting and pocket mats (Cost per square, $8.73.)	14,465.98
Cost of 20,616 square yards of paving, including clearing bank, hydraulic and hand grading, etc. (Cost per square yard, $1.133.)	23,357.92
Cost of miscellaneous work and repairs not classified	2,731.30
Total	101,295.47

The cost of the mattress lost had been included in the above, as it was completed and almost sunk when the rupture occurred. The cost per square was within 9 cents of the average cost, and the stone used was sufficient for sinking, had no accident occurred.

The total cost of new work was	$78,604.28
Deduct mattress lost	11,359.42
Leaves for cost of work placed	67,244.86

The effective length of the channel mats is 2,466 feet, and length of bank paved 2,558 feet.

The revetment extends above the head of the channel mats from station 38+08 to 40+60, a distance of 252 feet, where 389 squares of connecting mats were placed.

Practically we may estimate that the bank protected with complete revetment equals the length of the paving, or 2,558 feet, and this will give a cost of $26.29 per linear foot.

The reconstruction of the revetment along the large pocket caves of the 1891 work cost in gross $17,118.01 for 840 linear feet, or a cost of $20.38 per linear foot.

The following table shows the quantities of material used per unit of work:

	9,020.6 squares channel mats (per square).	1,656.3 squares connecting mats (per square).	20,616 square yards paving (per square yard).
Brush ... cords..	1.3810	1.256	....
Poles ... do....	.0670	.048	....
Stone ... cubic yards..	.6895	1.128	0.310
Wire, No. 12 ... pounds..	2.2520	3.132	....
Wire, bronze ... do....	.4010	.033	....
Wire strand, ¼-inch ... do....	6.0180	6.050	....
Wire strand, 5/16-inch ... do....	2.8380	2.340	....
Wire strand, ⅜-inch ... do....	1.8360	.410	....
Wire strand, ⅛-inch ... do....	1.2630	1.377	....
Clips, assorted ... number..	1.0990	....	....

WOLF RIVER.

The work of dredging Wolf River was begun on August 10, when the dredge boat *Wolf*, steamer *Abbot*, and two dump scows were moved to the mouth of the river and cut out a shoal there. The stage at the time was 11.7 feet, and as this was too high for general operations in the lower part of the river, the dredge was moved on the following day to above the railroad bridge, where it was employed in removing snags and in dredging between the railroad bridge and the county bridge until September 29. During this time the river was at a fairly high stage, varying between 9.6 and 13.5 feet.

From September 29 to November 17 dredging was done between the mouth and the railroad incline. On the latter date a bad shoal appeared a short distance below the railroad bridge, or nearly abreast of the Anderson-Tully mill incline, and the dredge was moved there and was engaged until December 3 in removing it. This shoal was formed about a number of sunken snags and saw logs matted together, which had no doubt drifted there during a late run out. From December 3, 1903, to January 2, 1904, dredging was done between the mouth and the railroad incline, the stage varying between 5.6 and 1 foot, which was the lowest water of the season. Navigation was somewhat interrupted during this period for about a week by the transfer steamer *Pierson* getting aground and partially blocking the channel. Very little dredging work could then be done, and the dredge was employed in assisting the steamer to float.

From January 2 to 13 a shoal produced by recent heavy local rains was removed from the vicinity of the mouth of Bayou Gayoso, and from January 14 to 20 a shoal near Cochrans mill was cut out. On the latter date the dipper caught against the end of a bottom plank of the dredge, breaking a hole which almost caused the dredge to sink and requiring docking for repairs. These were made in a few days, but as the river was rising, further operations for the season were suspended and the crew discharged.

The following shows the localities dredged and quantities removed:

	Cubic yards.
From mouth to incline	26,980
From shoal below Bayou Gayoso	3,840
From shoal in vicinity of Cochrans mill	2,160
From shoal between the Anderson-Tully and Hardwood mills	4,320
From railroad bridge to county bridge	15,040
Total	52,340

All of which was loaded into scows and towed to deep water in the Mississippi River.

The following obstructions were removed:

Snags	93
Saw logs	31
Stumps	6
Piles	13
Pieces of old barges (wrecked)	9
Section of train track	1
In all	153

Of these, 40 were from the mouth to incline, 10 from Cochrans mill shoal, 20 from Anderson-Tully mill shoal, and 83 above railroad bridge.

The field cost of the work was as follows:

For operating dredge:	
Labor	$2,876.42
Fuel	911.92
Machinery, repairs, and materials, including new chain	473.30
Oils and engineer supplies	105.31
Ice	12.05
	4.379.00
For operating tender boat:	
Labor	1,840.33
Fuel	503.12
Machinery, repairs, and material	24.42
Oils and engineer supplies	30.10
Ice	12.05
Total field cost	6,789.02

Distributed as follows:

For removing 153 snags, at $5.23	$800.87
For dredging 52,340 cubic yards, at $0.1144	5,988.15
	6,789.02

The total expenditures from May 1, 1903, to March 31, 1904, were as follows:

For operating dredge and tender as above	$6,789.02
Repairs to floating plant	565.95
Property purchased	62.65
Total cost	7,417.62

On the basis of total expenditures the cost will be $5.72 per snag and $0.1248 per cubic yard of dredging.

HELENA, ARK.

The revetment work at this locality, covering 4,900 linear feet of the bank, is described in the Report of the Mississippi River Commission for 1903, page 173. No damage was done to the completed portions by the flood of 1903, but where the revetment extended to but a short distance above the low-water line, as is the case between the dikes, there was some bank loss. This was aggravated, where the water fell to a low stage late in the fall, by the sloughing of the banks.

The caving was confined to two pockets, situated between Dikes Nos. 2 and 3, with Dike No. 2½ forming a salient between the pockets. These pockets had been caving slowly for several years past, caused principally by sloughing of the banks when the river was low, and an attempt had been made to check this in 1902 with drains to remove the seep water. These, however, were unfinished constructions and afforded but little relief. The pockets finally enlarged from dike to dike, being each about 175 feet long, the upper one caving to within 70 feet of the toe of the levee and the lower one to within 40 feet, and the shore edge of the mattress, originally about 3 feet above the zero stage, had settled at one place about 20 feet. The situation was rather dangerous on account of its nearness to the levee and demanded immediate repairs.

The bank along this revetment from a short distance below Dike No. 3 to near its lower end had settled during past low waters. This showed itself in a crack along about the 26-foot stage line of the Helena gauge, the amount of drop varying from a little to over 5 feet at the crack, and apparently nil halfway down the slope to low water. Practically no disturbance in the mattress revetments or dikes could be observed.

On December 22, when the river had fallen to the 3-foot stage, a very extensive settling of the bank occurred, extending from just above Dike No. 3 to about 500 feet below Dike No. 4, a length of about 1,000 feet. Both dikes and the shore line near them were apparently undisturbed, but back of the dikes the ground had settled along a crescent-shaped area, having a width of about 125 feet behind Dike No. 4. Here the subsidence is the greatest, being about 20 feet near the toe of the levee and thence decreasing to zero at the head of the dike.

At Reaves mill incline, just below Dike No. 3, the bank was undisturbed from the zero line to about 70 feet inland, thence for 120 feet the vertical drop was about 8 feet average, the break approaching to within 50 feet of the levee toe.

The settling was greatest inshore and least toward the river, and extended to the low-water line only at its extremities, and at one place just above Dike No. 4 where there was no revetment. The settling near the low-water line was in all places small, and where the bank had been reveted, as at the lower end, the mattress work appeared to be intact.

This settled territory covered in its entirety a similar settling which occurred in October, 1889, and with an additional extension of about 200 feet upstream back of Dike No. 3.

Besides the large settling just described, the bank below it further settled along approximately the 26 feet contour from about 200 feet above Dike No. 5½ to near the end of the revetment, the maximum settling being from 2 to 4 feet. All of this was along revetted bank, the revetment of which was uninjured.

The project formulated for the expenditure of the small fund available was to revet the two deep pockets between Dikes 2 and 3 with mattresses from the bank to overlap the channel mats, build up across each pocket a crib dike to reduce eddy action, and place brush drains where deemed necessary to remove seep water and prevent further sloughing.

Also, to make borings along the top of the bank of sufficient depth to determine the character and thickness of the stratifications through which the seep water flows, this information being necessary for devising any plan for preventing sloughing or settling.

Construction.—The work of repairing the pocket caves was begun January 7 and completed on the 27th. The following was done:

CONNECTING MATS.

Two connecting mats were placed in the pocket between Dikes 2 and 2½, and 2 between Dikes 2½ and 3. These mats lapped over the channel mats and connected with the 7 to 9 feet contour on the bank.

Dikes 2½ and 3 were repaired with a small piece of mat work on each.

The dimensions of the mats placed were as follows:

Between Dikes 2 and 2½, 118 by 138 feet and 47 by 89 feet.
Between Dikes 2½ and 3, 102 by 96 feet and 77 by 110 feet.
On Dike 2½, 16 by 20 feet.
On Dike 3, 23 by 40 feet.

The total squares placed was 399.6.

CRIB DIKES.

Three crib dikes were built, one in the pocket between Dikes 2 and 2½, one between Dikes 2½ and 3, and Dike No. 3 was extended across the settled bank above its shore end.

The dimensions and volume of the cribs are as follows:

Dike between Dikes 2 and 2½, 20 feet long; average height, 3 feet; volume, 540 cubic feet.

Dike between Dikes 2½ and 3, 110 feet long; average height, 5 feet; volume, 9,350 cubic feet.

Dike back of Dike 3, 105 feet long; average height, 4 feet; volume, 4,410 cubic feet.

Total volume of crib dikes, 14,300 cubic feet.

DRAINS.

Two drain ditches were built between Dikes 2 and 2½, each 20 feet long, 3 feet wide, and 3 feet deep; three between Dikes 2½ and 3, aggregating 200 feet in length, 3 feet wide, and 4 feet deep, and one 30 feet long, 4 feet wide, and 5 feet deep under the extension of Crib Dike No. 3. The total of drains was 3,360 cubic feet.

BORINGS.

These were begun on January 7 and completed February 26. Fourteen holes were bored, ranging in depth from 50.5 to 121 feet, and aggregating 1,051.5 linear feet. Eleven of these were outside the levee, close to and some on the settled bank, and distributed along a distance of about 2,500 feet. These borings were made inside the levee and some distance back. They all show in general that the materials above the low-water line are blue muds or clays, mixed more or less with sand, and containing considerable water. Underlying this is a fine blue sand, usually somewhat coarser near the bottom, decidedly water bearing, and in some places "quick," and that this rests upon a hard brown clay, practically impervious, with its top from 36 to 39 feet below the zero stage of the river.

One hole bored through this brown clay showed a thickness of over 40 feet.

Soundings show that the bottom of the sand stratum outcrops in the river from 150 to 250 feet from the zero contour, the channel mats barely covering it in places, hence any retaining work designed to prevent a sloughing of this material would have to be placed far out in the river.

The following is a statement showing the elements of work and cost:

Connecting mattresses (399.6 squares):		
Labor, including subsistence		$1,185.76
Brush		537.15
Poles		36.00
Stone		480.00
Wire, No. 12		33.02
Wire strand		171.41
Staples		2.34
Clips		9.38
Miscellaneous materials		21.40
Property		6.50
		2,482.96
Superintendence	$148.17	
Care of plant	204.07	
Towing	962.26	
		1,314.50
Total cost, at $9.48 per square		3,797.46

Crib dikes and drains (17,660 cubic feet = 654 cubic yards):	
Labor, including subsistence	$513.20
Brush (210.5 cords)	229.45
Poles (54.8 cords)	109.60
Stone (90 cubic yards)	180.00
Wire, No. 12 (420 pounds)	10.71
Wire strand (731 pounds)	24.56
Clips (20)	.82
Superintendence	63.73
Care of plant	87.77
Towing	408.48
Total cost, at $2.49 per cubic yard	1,628.32
Borings, 14 holes from 50.5 to 121 feet deep (total length of holes, 1,051.5 linear feet):	
Labor, including subsistence	785.42
Material and repairs to tools	82.34
Property	30.24
Superintendence	53.64
Care of plant	73.88
Total cost, at $0.975 per linear foot	1,025.52

SUMMARY.

Connecting mats, 399.5 squares, at $9.48	$3,797.46
Crib dikes and brush drains, 654 cubic yards, at $2.46	1,628.32
14 borings, 1,051.5 linear feet, at $0.975	1,025.52
Total field cost	6,451.30
Expended for surveys	645.17
Expended in main office	92.77
Total	7,189.24

Although the revetment has settled in some places, it appears as a whole to be fairly effective; especially is this the case along the fascine mattresses, where no breaks have occurred by high-water attacks.

Between the dikes the revetment was never completed to the top of the bank. This should be done as soon as funds can be obtained.

Very respectfully,

W. M. REES,
Assistant Engineer.

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

APPENDIX 2 C.

REPORT OF MR. A. J. NOLTY, U. S. ASSISTANT ENGINEER, ON PLANT PARTY, AT MEMPHIS, TENN., DURING SEASON OF 1903-4.

MEMPHIS, TENN., *May 1, 1904.*

CAPTAIN: I have the honor to submit the following report of the plant party at Memphis, Tenn., for the season of 1903-4.

Steamer Chisca.—This vessel, built in 1897, required repairs to hull, and as our floating dock was not large enough to take this boat it was sent to the Paducah Marine Ways Company, to be taken on the ways there, this firm being the lowest bidder, at $3,901.26. Repairs to machinery, furnace, decks, and cabin and painting, was done at the fleet. This steamer is now in good condition except that there are a few cracked plank in the bottom, caused by striking the reef outside the fleet last winter. This damage has been repaired and does not impair the seaworthiness of the boat.

Steamer Titan.—This boat was built in 1887 and was in service up to the end of 1900. During the period of service it was twice taken on our dock and repaired, was sunk on the bar above river Styx and repaired there and then sent to St. Louis to be taken on the ways for repairs. After returning from the latter place the boat did very little service, and early in 1900 it was laid up. It is a well-known fact that a vessel deteriorates much more rapidly while out of service than when in, and therefore it was decided to either have the boat transferred or condemned and sold while it possessed some value, or repaired. As we were short of towboats, the latter course was finally decided upon early in 1903, and as our dock had by this time become so much weakened by age as to lack the proper stiffness to straighten a vessel the size of the *Titan*, it was decided to send it up to the Paducah Marine Ways with the *Chisca* for a thorough repair to hull, all repairs to machinery, cabin, decks, wheel, etc., to be done at the fleet. The *Titan* was received at the fleet September 18, 1903, and the alterations on the cabin were begun the following month. These consisted in shifting the district officer's observation cabin, staterooms, closets, etc., from the after to the forward end, and adding an extension to the observation cabin forward of everything. The quarters and dining room for the boat's officers were shifted aft. Other additions consisted in building quarters for the deck crew and for the firemen in the after end of the engine room, and providing for carrying of two horses. Engines and all other machinery were overhauled, boilers repaired, furnace rebuilt, new wheel built, steam heating plant, electric-light plant, and hot and cold water supply installed, and the whole boat thoroughly painted inside and out. The boat has been in commission since the beginning of the year and its performance is very satisfactory.

Steamer Graham.—A new cabin was put on this boat in 1902. The hull was rebuilt during the past year and the boat is in first-class condition. Other work done on the boat consisted in repairs to furnace, wheel, painting and the removal of an unsafe donkey boiler and the placing of a safe one.

Steamer Abbot.—This boat received minor repairs to hull, cabin, and machinery. It will require some additional repairs of small cost this year.

Steamer Itasca.—This boat had two new sheets put in boiler and has received minor repairs to cabin, wheel and machinery. Has also been painted. Will be docked as soon as practicable for inspection, cleaning, and painting of hull. Present condition fair.

Hydraulic grader No. 2.—This machine during the past year has received the usual overhauling of pumps, boilers, and furnaces, and has had hull and deck calked while afloat. It is now in the dock undergoing repairs to hull. While at work at Hopefield Bend last winter one of the water chambers developed a large crack. With the intention of repairing this chamber, if possible, it was stripped, when it was found that it was cracked in two places on the side opposite the first-mentioned crack. There is no remedy now except a new chamber.

When the machine comes off the dock and the new chamber is put up it will again be in good condition. This grader was built in 1881 and has been at work every season, except five, since.

Hydraulic grader No. 9313.—The above number is that of the barge rebuilt as hull for this machine, which will take the place of condemned grader *No. 40*, and the pumps of which are now being set up on the new hull. Two of the three boilers from condemned grader *No. 4* have been repaired and set up. One end of this hull will be fitted up for pile driving, thus eliminating one hull. The hull is completed, boilers and main pumps set up, and the cabin is now being built, leads erected, and balance of machinery and piping put up.

Pile driver No. 6.—Owing to shortage of grading plant last season, a duplex Worthington pump was set up and this machine then used for grading at Plum Point reach. The pump furnished one 1-inch jet under 175 pounds pressure. The machine did excellent and cheap work, but, of course, progress was slow. Condition good.

Pile driver No. 9.—This machine received only such temporary repairs as to make it serviceable for the season's work. It will be docked this season for rebuilding of hull. Present condition unseaworthy. Both Nos. 6 and 9 belong to the works above Cairo and were loaned to this work three years ago.

Machine shop.—The line shafting was lined up, boxes rebabbited, hull calked, and deck repaired. It is intended to dock the boat this season for repairs to hull. Present condition fair.

Dredge Wolf.—This machine, used for dredging in Wolf River, was docked for repairs to hull. In addition the outboard half of the boom was entirely rebuilt, this being necessary by reason of the timber used in former construction having warped badly. New foundations were put under the shears, two new side spuds and spud guides put up, new and heavier iron dipper bails made, and machinery and rigging overhauled. The dredge was docked the second time during the year for the purpose of repairing damage done to the bottom by the dipper, which, after wearing away the 4-inch protection sheathing during operations, finally loosened the ends of several of the bottom planks. As no allotment for dredging Wolf River was made for this season, no repairs to this machine will be made this year. Present condition fair.

Dump scows (*2*).—These belong to the Wolf River outfit. They were calked all around and had the bins resheathed. Present condition good.

Quarterboats Nos. 11, 25, 39.—Received only minor repairs to hull and cabins. Present condition good.

Quarterboats No. 27, Amelia and Mississippi.—These are field headquarters and office boats. They received only minor repairs, sufficient to enable them to be taken into the field. All these are in bad condition, and must be docked for rebuilding of hulls before being again taken out.

Quarterboat No. 12.—In bad condition, and must receive extensive repairs before again fit to be taken out.

Storeboats Nos. 8 and 26.—The former received some necessary repairs, such as calking, repairing guards, and putting up new fenders and timber heads. Both are in bad condition and must be docked this season.

Floating dock.—This was calked, had new dunnage put in and 14 new 12 by 12 inch by 36 feet sills laid down. Present condition good except that it needs a new top chord.

Mooring barges.—Nos. 1 and 2 were entirely rebuilt. Model barges Nos. 9406 and 9409 were docked and changed into square-ended mooring barges. These 4 barges are now in good condition.

Mattress barges.—Nos. 5 and 6 were rebuilt the previous year and were simply calked during the period. Square barges Nos. 9308 and 9312 were changed into mat barges, all old ones being beyond repair. With the 4 mooring barges and 4 mat barges we now have, once more, a first-class duplicate mat plant. In order to effect an improvement in the old method of hauling taut the sewing strand when constructing mat, a small portable winch was designed, and after this was thoroughly tested 75 of them were built here at a cost of $15 each. These winches not only do the work much better and more cheaply, but also eliminate the necessity for frequent changing the hauling gangs to other work, as by the old method of hauling with tackle blocks, the hands of the men become very sore. These machines, the cost of which has been charged to the two mat barges rebuilt the past season, have been more than paid for during the past season by cheapening this class of work.

Barges, fascine (*4*).—Two of the old 1889 framed barges were fitted up for use as fascine barges and were docked to have hulls patched and calked. The two old ones received only slight repairs.

Barges, model.—As previously stated under "Mooring barges," two of these were changed into square-ended mooring barges. As the cost of rebuilding this type of barge was found to be equivalent to the price originally paid for them, no more were rebuilt. Three of these received repairs sufficient to enable them to be used for light loads. Two were rebuilt the previous year, which leaves six of that class unrepaired. It is recommended that two, entirely unserviceable, be condemned and dropped and that the other four be retained a year or two longer, as they can be used about the fleet.

Barges, square (*1893*).—Five of these were rebuilt during the season, but one of them still lacks the new deck. The two changed into mat barges and the one rebuilt for greater hull are not included in the above. There remain ten of this class of barges unrepaired, and it is the intention to repair at least eight of these this season besides docking and repairing the four rebuilt in 1899. The new work when rebuilding these barges amounts to from 80 to 90 per cent of the original cost, and the barges are practically as good as new. The average original cost of these barges was $3,018, while the cost of rebuilding may be taken at $2,500.

Flats.—One 60 feet long, 16 feet wide, and 4 feet deep was built. All timber used in construction was first treated to a coating of spirittine wood preservative, a second coating being applied the same as paint when the boat was completed.

Models.—The models made for the Paris Exposition and subsequently exhibited at Buffalo, N. Y., were repaired and repainted or revarnished. The model of hydraulic grader was entirely reconstructed. The mat-plant model was changed so as to exhibit improvements added since the original was made.

A detailed statement of expenditures on account of care of and repairs to plant accompanies this report.

Respectfully submitted.

Aug. J. Nolty,
Assistant Engineer.

Capt. E. W. Van C. Lucas,
Corps of Engineers.

Statement of expenditures on account of care of and repairs to plant for the season 1903–4.

Care of plant	$12,112.74
Superintendence	1,250.00
Steamer *Chisca*	5,651.10
Steamer *Titan*	17,834.53
Steamer *Graham*	4,310.97
Steamer *Itasca*	362.67
Steamer *Abbot*	289.54
Barge No. 209	540.50
Barge No. 229	515.99
Barge No. 9301	2,606.55
Barge No. 9303	102.00
Barge No. 9304	989.73
Barge No. 9305	75.00
Barge No. 9306	65.00
Barge No. 9310	986.75
Barge No. 9311	110.00
Barge No. 9315	2,515.81
Barge No. 9318	828.85
Barge No. 9321	78.50
Barge No. 9322	107.50
Barge No. 9324	69.40
Barge No. 9325	2,594.89
Barge No. 9326	82.00
Barge No. 9328	2,621.50
Barge No. 9329	113.25
Barge, mattress No. 5	38.00
Barge, mattress No. 6	38.00
Barge, mattress No. 9308	3,194.75
Barge, mattress No. 9312	3,204.33
Barge, model No. 9401	38.50
Barge, model No. 9403	49.00
Barge, model No. 9404	31.75
Barge, model (mooring) No. 9406	2,669.80
Barge, model No. 9407	82.00
Barge, model No. 9408	73.75
Barge, model (mooring) No. 9409	2,565.90
Barge, model No. 9410	41.25
Quarterboat No. 8	196.25
Quarterboat No. 11	130.00
Quarterboat No. 25	133.30
Quarterboat No. 27	200.00
Quarterboat No. 29	17.00
Quarterboat No. 206	296.01
Quarterboat No. 221	228.66
Quarterboat *Amelia*	33.50
Mooring barge No. 1	1,794.60
Mooring barge No. 2	1,803.59
Pile driver No. 6	105.60
Pile driver No. 9	180.00
Flat, 60-foot	650.00
Grader No. 2	611.08
Grader No. 9313	3,823.89
Machine boat	671.47
Floating dock	774.22
Miscellaneous	2,029.19
Dump scows	274.50
Dredge *Wolf*	890.51
Purchase of tools, appliances, and mess outfit	2,083.33
Tools and appliances, repairs to	2,032.93
Total	87,801.43

APPENDIX 2 D.

REPORT OF MR. ARTHUR HIDER, ASSISTANT ENGINEER, ON SURVEYS, CONSTRUCTION WORK, CARE AND REPAIRS TO PLANT, STONE, ETC., IN THIRD DISTRICT, FOR THE SEASON OF 1903–4.

GREENVILLE, MISS., *May 1, 1904.*

CAPTAIN: I have the honor to submit the following report on surveys, construction work, care of and repairs to plant, quarrying and towing stone, in Third District, from May 1, 1903, to May 1, 1904:

SURVEYS.

A survey party was organized under the direction of Mr. Luther Y. Kerr, junior engineer. The following extracts from Mr. Kerr's report give condition of the revetments as shown by this survey:

"The survey party began work August 25 and was disbanded November 18, during which time the regular low-water surveys were made at the following points: Revetment surveys at Lake Bolivar Front, Ashbrook Neck, Greenville Harbor, Lake Providence, and Delta Point; shore line surveys on the upper side of Caulks Neck and Carters Neck, and the survey of a part of Lake Providence Reach, to show the effect of the dredge work.

"In addition to the above, hydrographic surveys were made in the vicinity of the La Grange and Hollybrook crevasses, extending over about 3¼ miles of river at each point. These are the first of a series of surveys to be made to study the effect on the channel due to the closing of crevasses.

CONDITION OF REVETMENTS.

"*Lake Bolivar revetment (417 L.).*—There is no change on sections 6 + 05 to 13 + 60. On section 14 + 55 there is a slight scour on the outer end, which increases in depth down the river through the remaining sections; this scour, however, is well out beyond the mattress, except from range 25 + 60 to range 6 + 28. No change in bank line.

"*Ashbrook Neck revetment (446 L.).*—Beginning at the upper end, there has been a slight scour at the outer edge of the mattress from ranges 150 to 139. No change from ranges 138 to 112. Ranges 110, 108, and 105 show considerable scour on the shore edges of the sections. A very heavy scour has occurred on the outer end of sections from ranges 4 to 29, the lower end of the work. The bar line has moved shoreward from range 151 to range 8. On range 151 the change amounts to about 200 feet, and increases to 600 feet on range 114, decreasing from that point to zero at range 8. It maintains about the position of that of last year from ranges 8 to 14 and then moves shoreward again at the lower end of the work, amounting to 300 feet on range 28. The maximum amount of caving, both above and below the work, has been about 130 feet.

"*Greenville Harbor (478 L.).*—The sections show very heavy scour on ranges 102, 103, and 104, which resulted in a small break in the upper slope at that point. From ranges 105 to 118 there is no change. From ranges 109 to 136 considerable scour occurred through the sections, causing a slough in the upper slope from ranges 119 to 125. From range 137 to range 0, and from range 0 to 27, there has been no material change. From ranges 28 to 43 more or less scour has occurred, the greatest being on ranges 32, 33, and 34, where it amounts to 35, 25, and 15 feet, respectively. A slough may be expected at this point. No change from ranges 44 to 55. From range 55 to 66 a very heavy scour occurred, causing a break in the upper slope from range 57 to 60. No change from ranges 67 to 74. Range 75 shows considerable scour, which develops into a very heavy scour on range 76, amounting to 35 feet on the inner half of the section. The bar line has moved back 400 feet on the upper end and 500 feet at the lower end, while from range 125 to range 56 it has moved about 100 feet back from last year's position.

"*Lake Providence revetment (517 L.).*—The sections over the work show some radical changes. The Longwood bar has moved down in front of the Louisiana shore to range 120, and the sections from 120 to 140, the upper end, are filling rapidly. This fill extends down as far as range 100.

"From ranges 96 to 32 the bar has moved shoreward from 300 to 600 feet, and is causing a very strong attack on the revetment from ranges 84 to 14, the lower end of the work. Two sloughs occurred in this stretch, one between ranges 78 and 83 + 50, extending back beyond the top of the main bank, and the other, a small one, occurred at range 30, and extending up the slope to a point about 20 feet above the zero of the Lake Providence gauge."

"*Delta Point* (*598 R.*).—The sections over the work show a general scour over the entire reach. There is now a strong impact against the point from ranges 1 to 5 west."

The expenditures of the survey party were as follows:

Pay roll	$3,327.84
Subsistence	713.29
Material	586.74
Total	4,627.87

CONDITION OF NECKS.

Caulks Neck (*410–423*).—The survey of 1903, compared with that of last year, shows that at the narrowest part of the neck the maximum distance that the main bank on the upper side has receded, due to caving, is 100 feet.

The maximum caving which had taken place from 1889 to 1902 was 750 feet, an average of about 60 feet yearly. Three thousand feet below the narrowest part of the neck the maximum caving during this period was 1,200 feet. The greatest activity in caving is now about half a mile below the narrowest part. The shortest distance between the main bank lines on each side of the neck is 3,800 feet.

Ashbrook Neck (*446–455*).—Due to the fact that the upper side of this neck is revetted and the revetment is in good condition, and also because there exists a heavy growth of timber at its narrowest part, this neck is practically safe from danger of cut-off as long as these conditions continue, although the distance at the narrowest part between bank lines on the opposite side is now only about 2,000 feet.

Carters Neck (*461–474*).—Along the upper side of this neck the average yearly bank recession from 1889 to 1902 was 203 feet, and the maximum caving at the narrowest part last year was 300 feet. For a mile or more above and below the narrowest part the shore lines of 1889 and 1903 are nearly parallel, showing that there is no particular tendency to excessive caving at the narrowest part. The distance between the main bank lines on each side of the neck is now 3,250 feet.

From present indications there seems to be little likelihood of a cut-off, either at this neck or at those above, for several years.

Leland Neck (*470–484*).—Opposite the washout made during the high water of last year, the distance between the bank lines is about 3,500 feet. This point may be considered as the narrowest part of the neck, as above this, on the underside, a sand bar covered with a heavy growth of willows makes out into the river.

The recession of the bank on the upper side of the neck, due to caving since 1882, has been 2,400 feet, a yearly average of 200 feet. Last year the bank caved from 250 to 300 feet at the narrowest part.

It is not believed that the effect of the dike constructed out on the point last year to prevent a cut-off will have any tendency to reduce the rate of caving on the upper side, except possibly during the time of high water. In order to accomplish the object for which the dike was constructed, it is recommended that it be extended a considerable distance out on the point beyond its present terminus, and, for safety, that the present section be increased to 8 feet crown, slopes one on three. The extension of the dike will prevent washouts occurring where the distance across the neck is such as to render them dangerous.

As this dike, for a long stretch, is only from 1,300 to 1,600 feet from the river on the upper side, it is evident that should the present rate of caving continue, the upper bank must soon be revetted. Very considerable risk will be taken if this work is delayed longer than another year.

As the bank on the upper side of Ashbrook Neck is revetted, and the distance across the necks at Caulks Point and Carters Point is sufficient to allow the present rate of caving to continue several more years before it becomes absolutely necessary to build revetment or dikes out on these points to prevent a cut-off, these necks may be considered comparatively safe unless some radical changes occur in the regimen of the river immediately above or below them. The greatest danger of a cut-off on either of the necks is at Leland. A cut-off might occur during a high water by the beaching of the dike built last year, or its destruction by encroachment of the caving on the upper side; for these reasons the above recommendations were made for the strengthening and extension of the present dike.

CHANGES AT LAKE PROVIDENCE.

For several years past, until 1902, great difficulty had been experienced in holding the upper end of the Lake Providence revetment, due to the main current of the river crossing from the opposite side and directly attacking this point, this action of the river being due to the configuration of the channel above. To counteract this it became necessary every year to do a large amount of reinforcing work to hold this part of the revetment intact and prevent flanking. As the bank was rapidly caving above and there was an important levee line which was within 400 feet of the river bank, and which protected the town of Lake Providence, the levee would have been jeopardized unless the caving could be checked.

To relieve the situation, in the latter part of 1901, a channel was dredged across and around the point of the sand bar on the opposite side. This sand bar had for several years been building up and extending toward the Louisiana shore and narrowing the channel width, which was accompanied by a corresponding deepening of the river bed along the front of the revetted bank.

A channel about half a mile long and 10 feet deep was excavated between ranges 13½ and 15 during a very low stage of water. After the first rise of any moment, a decided improvement was indicated, shown by the cutting away of the face of the sand bar where the dredging was done. This has been followed by a shoaling of the river in front of the revetment at the upper end, due to the change of the abrupt crossing that formerly existed. These changes continued during 1902 and 1903, and have resulted in the formation of a middle bar, and the extension of the shore bar on the right bank until the upper part of the revetment is masked from any direct attack from the river and may be considered secure for several years to come.

Below range 17 (station 84, revetment surveys), to the lower end of the revetment, the effect of the middle bar dividing the river into two channels will be to throw an additional strain on the lower end of the revetment for the next two or three years, as indicated by the revetment surveys of the past season.

With the extension of the shore bar above and the moving of the middle bar downstream, which changes are in all probability now in progress, the entire upper half of the revetment from ranges 72 to 140 may be considered secure. Below range 72 to the lower end it is altogether probable that considerable repairs will be needed the present season, as this part of the revetment will now have to withstand the greatest strain.

The effect of the dredging in inducing the changes in channel that have taken place in this locality is somewhat problematical, as the extension of the shore bar below Longwood has contributed very materially in effecting these changes. However, it is believed that the indications are that the result of dredging across points similar to that referred to above will be beneficial in many instances in diverting the caving from threatened points, and would be justified where important levees are to be protected.

REPAIRS TO REVETMENTS.

The original project at the beginning of the season was for the construction of 4,000 linear feet of standard revetment in the way of repairs, with minor repairs to the upper bank slope where necessary, distributed as follows:

	Linear feet.
Lake Bolivar front (minor repairs).	
Ashbrook Neck	2,000
Greenville Harbor	1,000
Lake Providence	1,000
Delta Point (minor repairs).	
Total	4,000

Lake Bolivar revetment (417 L.).—No repairs to the subaqueous work were deemed necessary. The only work done was regrading and repaving parts of the upper slope where broken.

Ashbrook Neck (446 L.).—The revetment along this entire front was found to be in fairly good condition, considering the ordeal it has undergone on account of the rapidity of the current and the large volume of water flowing across the neck at its narrowest part during the last high water.

The principal changes noted were a steepening of the upper bank slope from ranges 107 to 110 and a very considerable scour from ranges 4 to 26, a distance of about 2,200 feet at the lower end of the revetment, showing the necessity of reenforcing this part of the revetment with mats.

The first reenforcing mat, 1,000 feet long, was constructed between range 83 and range 5. On account of the old mats being in good condition from range 5 to range 15 no work was done on this section.

The second reenforcing map was begun at range 14-50 and constructed as far as range 22, a length of 830 feet, overlapping the reenforcing mat at the latter point.

The length of bank which has not been reenforced by fascine mats is 1,150 feet, from range 93 to range 104, and 900 feet between range 5 and range 14. This portion of the revetment was apparently in good condition, with no signs of settlement of the upper bank.

Two small sloughs in the upper bank occurred in December, 1903—one between range 9 and range 10, and the other between range 11 and range 12, less than 100 feet each, apparently due to the weight of deposit (15 feet or more in depth), pushing out the lower slope. The material is very unstable and impregnated with seep water from an old cypress brake in the rear. As the mat in front was in good condition, these defects were remedied by covering the broken sections with a light layer of brush, the latter held in place by a light layer of stone.

Along this revetment the zero line of the sand bar at range 151 has moved over toward the revetment about 200 feet; at range 115, 700 feet; at range 8, 200 feet, and at range 10, coincides with the zero line of last year. At the extreme lower end of the revetment the zero line has moved in toward the shore 200 feet.

Greenville Harbor (*478 L.*).—After the high water the Greenville revetment showed three breaks in the upper bank between ranges 103 and 105, ranges 118 and 126, and ranges 57 and 60. The break between ranges 103 and 105 was merely a cutting away of the upper bank, due to eddy action and to the rapid current flowing around the point. The break between ranges 57 and 60 was caused by scour. These two breaks were repaired by regrading and repaving and the sinking of one pocket mat at each place. The break between ranges 118 and 126 occurred just above where the reenforcing mat built last season terminated; in other words, in a gap of 600 feet between the fascine mats. It was intended to construct a mat last season to cover this gap, but the lateness of the season and the urgency of the work required at Lake Providence necessitated the removal of the party to the latter place, leaving this space unprotected. This break has been repaired by pocket mats and a channel mat 250 feet wide connecting the two fascine mats, and restoring the upper bank revetment.

Lake Providence revetment (*517 R.*).—A considerable fill took place over all the sections during the year, from the upper end of the revetment (range 140), downstream to range 100. Between ranges 100 and 83 little change had occurred. From ranges 83 to 72 scour had taken place, indicating that the mat, one of earlier construction, had been greatly injured if not destroyed.

The reenforcement of channel mats last season extended down to range 82. Below this to range 78 a deep pocket about 250 feet deep was scoured out. Along the upper bank in front of this hole the bank has been regraded and the space between the new bank line and the edge of the old mats filled in with pocket mats. A channel mat 250 feet wide and 800 feet long was constructed to cover this break in the revetment.

Below this, range 72 to range 22, a considerable scour and settlement of the revetment had occurred at different points. This is greatest between ranges 38 and 28, a length of about 1,000 feet. A reenforcing mat was constructed over this space. It was anticipated at the time this mat was built that an extension of same would be required, as the change in the river channel above, due to the formation of a middle bar, will subject this part of the revetment to a very great strain during the coming high water.

The season's repairs were finished December 12, 1903. On March 13 a cave in the upper bank occurred below range 28. This break at the time was about 700 feet in length and will in all probability increase after the river recedes within its banks. It will be necessary to repair this work during the coming working season by the construction of one or more channel mats.

As the banks are now under water it is impossible to state the exact amount of damage done.

Delta Point (*598 R.*).—From range 0 east to range 6 and from range 0 west to range 6 in front of the present revetment but little scour has taken place. The condition of the work is good. Above this, as far as range 46, considerable caving has taken place. The shore line is very irregular along this stretch, having caved out in pockets. Below the portion of the point which is revetted no change of importance has occurred. No repairs were made to this revetment.

So far as known the different revetments are in fair condition, except the one break in the lower part of the Lake Providence revetment above referred to.

The amount and cost of these repairs are given in detail in the report of Mr. Geo. C. Thomas, superintendent, who had direct charge of this work, as follows:

REPORT OF MR. GEO. C. THOMAS, SUPERINTENDENT, ON REVETMENT WORK IN THIRD DISTRICT DURING SEASON OF 1903-4.

GREENVILLE, MISS., *May 10, 1904.*

SIR: The following report of construction party in third district is respectfully submitted.

LAKE BOLIVAR FRONT.

The work consisted in regrading and repaving numerous small breaks in the upper bank, caused by wave wash or the passage of surface water over the slope. A small outfit was organized especially for this work and began operations on December 23.

One hundred and thirty-eight squares of bank were repaired at a cost of $7.66 per square. The work was completed on January 10 and the outfit merged with the main party at Ashbrook Neck.

ASHBROOK NECK.

The work proposed was the regrading and paving of several small sloughs or breaks in the upper bank, and the construction of about 2,000 feet of channel mat to reenforce the original work. Operations were begun on December 14, the outfit being transferred from Lake Providence, La.

Four small breaks in the upper bank, aggregating 242 squares, were regraded and repaved. Grading was done by hand, and but little stone was required for paving, in addition to amount stripped from breaks. Channel mats were constructed as follows:

	Squares.
Mat No. 1 (range 83+50 to range 4+50), 1,000 by 250 feet	2,500
Mat No. 2 (range 14+50 to range 23), 830 by 250 feet	2,075
Total	4,575

Mats constructed were of the usual fascine type, containing 3.3 cords of brush per linear foot.

Only one pocket mat was constructed, it being necessary to complete a shore connection between ranges 14+50 and 16.

A careful inspection was made of the work above water, and all minor damage resulting from wave wash or the passage of surface water over the slope was thoroughly repaired.

Brush and poles were furnished under contract by Messrs. Hunter & Frey, of Memphis, Tenn., loaded on Government barges at mouth of White River and at Scrub Grass bar. Stone was procured from reserve on bank at Greenville, Miss., loaded by Government force.

Towing and harbor work was done by the steamer *Arthur Hider* with double crew. The usual trouble was experienced in procuring labor for work at this point, it finally becoming necessary to import it from Memphis in order to complete the project.

The work was completed on January 30, and the outfit transferred to plant at Greenville.

GREENVILLE HARBOR.

The damage sustained by the work during the past flood stage was as follows: Range 103+50 to range 105, the sloughing of the upper bank destroyed the paving and lowered the shore edge of the subaqueous work. From range 117+80 to range 125+30 occurred the complete destruction of the upper bank work and a general lowering of the original mattress, this section not having been reinforced with fascine mats. Range 57 to range 60, the upper bank work was destroyed and the shore edge of the mat lowered in consequence. The damage at this point is believed to have been due to the passage of surface water over the slope. The different breaks were repaired in the usual manner by constructing channel or pocket mats in front of them and regrading and paving the upper bank.

Operations were begun September 4 and completed October 19, and the working plant transferred to Lake Providence, La.

LAKE PROVIDENCE.

The damage sustained by this work during the past flood stage was as follows: From range 26 to range 35 a general disruption of the subaqueous work and partial destruction of the upper slope; from range 77+50 to range 84 a decided lowering of the mattress by scour and a complete destruction of the upper bank work, the cave or pocket extending back a maximum depth of 200 feet beyond the original slope line. The working plant was transferred from Greenville Harbor on October 9, and operations were begun the following day.

A channel mat 250 feet wide, with necessary pocket mats or shore connections, was constructed and sunk in front of each of the breaks, and the upper bank resloped and repaved.

The work was completed on December 12 and the outfit tranferred to Ashbrook Neck.

Statements showing the cost of the different items of work are submitted herewith.

Very respectfully,

Geo. C. Thomas, *Superintendent.*

Mr. Arthur Hider,
United States Assistant Engineer.

LAKE BOLIVAR FRONT.

Statement of cost of regrading and paving.

Pay roll:		
December, 1903	$140.34	
January, 1904	207.51	
Total		$347.85
Subsistence:		
Amount expended in December, 1903	59.67	
Amount expended in January, 1904	92.77	
Total		152.44
Material:		
309.6 cubic yards stone, at $1.73	535.60	
137 bushels coal, at 11.5 cents	15.76	
20 gallons H. L. oil, at 16 cents	3.20	
4 gallons signal oil, at 42.5 cents	1.90	
Total		556.46
Total expenditure		1,056.75

Work done.—Bank regraded and repaved, 138 squares.

Average cost per square:	
Labor	$2.520
Subsistence	1.105
Material	4.032
Total	7.658

Cost per unit of different kinds of work, Ashbrook Neck.

Classification.		Units.	Pay roll.	Subsistence.	Material.	Total.	Cost per unit.
Channel mat	squares	4,575	$5,697.53	$1,710.16	$19,388.79	$26,796.48	$5.857
Pocket mat	do	75.8	81.36	24.42	296.66	402.44	5.309
Paving bank	do	242	318.18	95.50		413.68	1.709
Hand grading	linear feet	385	174.99	52.53		227.52	.591
Towing	days	49	2,087.99	486.52	1,745.44	4,319.95	88.16
Repairs old work			700.14	210.16		910.30	
Supervision			1,100.00	62.71		1,162.71	
Miscellaneous					482.03	482.03	
Property purchased					2,472.55	2,472.55	
Memphis office			697.50		201.45	898.95	
Total			10,857.69	2,642.00	24,586.92	38,086.61	

Note.—Loading stone: 3,960 cubic yards loaded at a total cost of $904.13, or 22.83 cents per yard. This cost is included in material cost of above statement.

Material expended per square of channel mat, Ashbrook Neck.

[1,830 by 250 feet, or 4,575 squares.]

Material.		Quantity.	Per square.
Brush	cords	6,118	1.335
Poles	do	270	.059
Stone	cubic yards	3,866	.845
Wire strand:			
⅝-inch	pounds	27,640	6.042
⅜-inch	do	4,887	1.068
5/16-inch	do	8,662	1.894
¼-inch	do	29,586	6.467
Wire, galvanized, No. 12	do	7,228	1.580
Wire, silicon bronze	do	2,859	.625
Staples	number	685	.150
Clips	do	475	.104

Material expended per square of pocket mat, Ashbrook Neck.

[75.8 squares.]

Material.		Quantity.	Per square.
Brush	cords	91.4	1.205
Poles	do	6.2	.0818
Stone	cubic yards	64.21	.847
Wire strand:			
5/16-inch	pounds	139	1.834
¼-inch	do	490	6.465
Wire, galvanized, No. 12	do	122	1.60
Wire, silicon bronze	do	48	.63
Staples	do	10	.132

The amount of stone expended on bank paving in this work was 300 cubic yards for 242 squares, or 1.24 cubic yards per square.

Percentage of cost of different items of work, Ashbrook Neck.

Kind of work.	Cost.	Per cent.
Channel mat	$26,796.48	70.35
Pocket mat	402.44	1.05
Paving bank	413.68	1.08
Hand grading	227.52	.60
Towing (double crew)	4,319.95	11.34
Minor repairs to old work	910.30	2.39
Supervision	1,162.71	3.06
Miscellaneous	482.03	1.28
Property purchased	2,472.55	6.49
Memphis office	898.95	2.36
Total expended	38,086.61	100

Percentage of cost of different charges, Ashbrook Neck.

Items.	Charge.	Per cent.
Pay roll	$10,857.69	28.51
Subsistence	2,642.00	6.94
Material, etc	24,385.47	64.02
Memphis office	201.45	.53
Total expended	38,086.61	100

Cost per unit of different items of work, Greenville Harbor.

Classification.	Units.	Pay roll.	Subsistence.	Material.	Total.	Cost per unit.
Channel mat............squares..	1,687.5	$2,341.75	$666.32	$7,171.94	$10,180.01	$6.032
Pocket mat.................do....	1,097.0	1,530.11	435.38	4,810.99	6,776.48	6.177
Paving bank ....do....	991.0	813.34	231.43	4,233.79	5,278.56	5.326
Hydraulic grading...linear feet..	1,080.0	563.43	106.52	236.28	906.23	.839
Dressing grade.............do....	1,080.0	197.44	56.18	....	253.62	.235
Repairs, old work........................		381.46	74.22	346.00	801.68	....
Towing ....days..	32.0	905.92	230.98	706.82	1,843.72	57.620
Supervision		410.00	43.04	....	453.04	....
Miscellaneous.............................			....	275.72	275.72	....
Property purchased....................			....	427.01	427.01	....
Memphis office..........................		458.20	....	137.24	595.44	....
Total..		7,601.65	1,844.07	18,345.79	27,791.51	....

Material expended per square of channel mat, Greenville Harbor.

[750 by 225 feet, 1,687.5 squares.]

Material.	Quantity.	Per square.
Brush ....cords..	2,740	1.624
Poles...do....	83	.049
Stone...cubic yards..	1,564	.927
Wire strand:		
⅜-inch ....pounds..	4,200	2.489
½-inch ....do....	2,000	1.185
5/16-inch ....do....	2,768	1.640
¼-inch ....do....	11,666	6.913
Galvanized wire, No. 12 ....do....	3,485	2.065
Wire staples..do....	175	.104
Wire, silicon bronze.......................................do....	909	.539
Clips...number..	900	.533

Material expended per square of pocket mat, Greenville Harbor.

[1,097 squares.]

Material.	Quantity.	Per square.
Brush ....cords..	1,782	1.624
Poles ....do....	53	.049
Stone ....cubic yards..	1,256	1.145
Wire strand:		
5/16-inch ....pounds..	2,742	2.500
¼-inch ....do....	7,584	6.913
Wire, galvanized (No. 12) ....do....	2,265	2.065
Wire, silicon bronze.......................................do....	591	.539
Wire staples..do....	115	.105
Clips...number..	425	.388

The amount of stone expended on bank paving in this work was 2,905.83 cubic yards for 991 squares, or 2.932 cubic yards per square.

Percentage of cost of the different items of work, Greenville Harbor.

Kind of work.	Cost.	Per cent.
Channel mat...	$10,180.01	36.63
Pocket mat	6,776.48	24.38
Paving bank	5,278.56	18.99
Hydraulic grading......................................	906.23	3.26
Dressing grade..	253.62	.91
Minor repairs, old work	801.68	2.89
Towing (single crew)..................................	1,843.72	6.63
Supervision	453.04	1.63
Miscellaneous..	275.72	.99
Property purchased....................................	427.01	1.54
Memphis office..	595.44	2.15
Total expended	27,791.51	100.00

Percentage of cost of the different charges, Greenville Harbor.

Items.	Cost.	Per cent.
Pay roll	$7,601.65	27.35
Subsistence	1,844.07	6.64
Material, etc	18,345.79	66.01
Total expended	27,791.51	100.00

Cost per unit of the different items of work, Lake Providence.

Classification.	Units.	Pay roll.	Subsistence.	Material.	Total.	Cost per unit.
Channel mat ....squares..	4,310	$5,514.94	$1,665.60	$17,292.86	$24,473.40	$5.678
Pocket mat ....do....	1,358	1,890.88	571.08	5,539.74	8,001.70	5.914
Paving bank ....do....	800	959.18	289.69	4,159.58	5,408.45	6.760
Hydraulic grading...linear feet..	1,120	510.23	107.58	276.73	894.54	.798
Dressing grade ....do....	1,120	121.74	36.77	....	158.51	.141
Hand grading ....do....	250	199.02	60.11	....	259.13	1.036
Towing ....days..	64	1,734.73	359.33	1,098.54	3,192.60	....
Repairs, old work	....	204.36	61.72	....	266.08	....
Dike	....	159.45	48.16	....	207.61	....
Supervision	....	985.00	75.70	....	1,060.70	....
Miscellaneous	....	....	....	455.07	455.07	....
Property purchased	....	....	....	938.29	938.29	....
Memphis office	....	898.70	....	154.68	1,053.38	....
Total	....	13,178.23	3,275.74	29,915.49	46,369.46	....

NOTE.—Stone loaded, 6,607.27 cubic yards, at a total cost of $1,486.50, or 22.497 cents per cubic yard. This cost is included in material cost of above statement.

Material expended per square of channel mat, Lake Providence.

[1,724 by 250 feet, 4,310 squares.]

Material.	Quantity.	Per square.
Brush ....cords..	6,025	1.398
Poles ....do....	271	.063
Stone ....cubic yards..	3,189	.740
Wire strand:		
⅝-inch ....pounds..	22,038	5.113
⅜-inch ....do....	2,916	.677
$\frac{5}{16}$-inch ....do....	10,257	2.380
¼-inch ....do....	26,636	6.180
Wire, galvanized, No. 12 ....do....	8,000	1.856
Wire, silicon bronze ....do....	3,000	.696
Wire staples ....do....	461	.107
Clips ....number..	724	.168
Clips (vulcan) ....do....	500	.116

Material expended per square of pocket mat, Lake Providence.

[1,353 squares.]

Material.	Quantity.	Per square.
Brush ....cords..	1,892	1.398
Poles ....do....	83	.062
Stone ....cubic yards..	1,218	.900
Wire strand:		
$\frac{5}{16}$-inch ....pounds..	3,924	2.901
¼-inch ....do....	8,364	6.182
Wire, No. 12, galvanized ....do....	2,509	1.855
Wire, silicon bronze ....do....	942	.696
Wire staples ....do....	144	.107
Clips ....number..	266	.197

The amount of stone expended on bank paving in this work was 2,200 cubic yards for 800 squares, or 2.75 cubic yards per square.

Percentage of cost of the different items of work, Lake Providence.

Kind of work.	Cost.	Per cent.
Channel mat	$24,473.40	52.78
Pocket mat	8,001.70	17.26
Paving bank	5,408.45	11.66
Hydraulic grading	894.54	1.93
Dressing grade	158.51	.34
Hand grading	259.13	.56
Towing	3,192.60	6.89
Minor repairs, old work	266.08	.57
Dike	207.61	.45
Supervision	1,060.70	2.29
Miscellaneous	455.07	.98
Property	938.29	2.02
Memphis office	1,053.38	2.27
Total	46,369.46	100.00

Percentage of cost of the different charges, Lake Providence.

Items.	Cost.	Per cent.
Pay roll	$13,178.23	28.42
Subsistence	3,275.74	7.06
Material, etc	29,915.49	64.52
Total expended	46,369.46	100.00

TOWING STONE.

At the close of last report, May 1, 1903, the quarry was still in operation. During the month of May, 1903, the cost of operating the quarry was $1,996.10. The amount of stone quarried and loaded was 2,035.4 cubic yards, and the cost per cubic yard 98.1 cents. This work was more than ordinarily expensive by reason of the varying height of the river between low and flood stages, the necessity of floating barges below the shoals by hand, extra watchmen, collecting and storing property, and the usual extra expense entailed in closing down the work for the season. On May 23 the work of quarrying was discontinued and the force disbanded.

The average cost of quarrying and loading stone on barges during the season of 1903 was 83.54 cents per cubic yard; average for towing to Greenville, 62.16 cents; average cost of unloading from barges on to the bank at Greenville, 16.4 cents, making the average cost of stone delivered on bank at Greenville for that season $1.62. About 14,336 cubic yards of stone were quarried. Practically all stone quarried was loaded on barges and the quarry left in good condition for 1904 work. A good, navigable stage of water was available in Little Red River throughout the season, except from January 18 to 25, 1903, and from May 1 to 9, 1903, at which time the water reached a stage of 1 foot on Big Island shoals.

Preparations for the present season's work were begun on February 4, 1904. Quarters were cleaned and fitted up, and quarry force was organized, and began work on February 15. The cost, so far, of the season's quarrying and loading on barges at the quarry, towing to Greenville, and unloading on the bank at that place is given below:

Date.	Quarried.	Loaded.	Towed.	Unloaded.	Cost of quarrying.
1904.	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*	
February	2,000				$2,184.74
March	6,000	1,650			3,631.79
April	2,630	4,980	4,361.3	2,204.9	2,653.05
Total	10,630	6,630	4,361.3	2,204.9	8,469.58

Date.	Cost of loading.	Cost of towing.	Cost of unloading.	Total cost.
1904.				
February				$2,184.74
March	$258.61	$1,139.69		5,030.09
April	1,032.44	2,010.32	$405.06	6,100.87
Total	1,291.05	3,150.01	405.06	13,315.70

The quarry force was employed until March 28 in quarrying and piling stone ready for shipment, the stage in Little Red River not being sufficient for the towboat and barges. The first tow of five barges and loading barge arrived on the 26th and loading began on the 28th.

The cost of loading included the rehandling and banking at the yard and the removal of all refuse from the present season's operations.

Considerable time has been devoted to stripping, cleaning up, and extending the limits of the present quarry, which now has an open working face of 600 feet, sufficient for the employment of 100 laborers, with an output of 600 cubic yards of stone per day.

A second boiler was installed during the season for the purpose of supplying steam drills on the lower ledges and for pumping to tank on top of cliff. With this additional boiler we now have ample power for the operation of four drills, the number required to work the present quarry to its full capacity.

As the season's work is only about half completed, the expense so far has been considerably above what the average of the entire season will be, as the cost given above includes all expense of organization, starting up work, and towing empty barges to quarry.

The average cost, so far, has been: For quarrying, 79.67 cents; loading on barges at quarry, 19.47 cents; towing to Greenville, 72.23 cents; unloading on bank at Greenville, 18.37 cents. Total cost on bank at Greenville, $1.897 per cubic yard.

During the month of April the funds for operating the quarry, towing, and unloading stone at Greenville have been provided by the board of Mississippi levee commissioners, as the stone is to be used in the Longwood revetment for the protection of the main levee at that place.

At the close of this report two tows, of six barges each, or 4,361.3 cubic yards, had been delivered at Greenville, and one tow, of 2,204.9 cubic yards, unloaded on the bank.

Six barges, loaded with 2,268.6 cubic yards of stone, are at the quarry ready for the towboat, which is now on the way there with a tow of empty barges. The steamer *Arthur Hider*, the only boat available, has been used for this work.

The cost of towing in previous years, as compared with the present season, is given below:

1893	$0.65
1894	.6425
1895	1.96
1897	.859
1901	.617
1903	.6216
1904 (partial season)	.7223

The quarry has been operated under the direction of Mr. Geo. C. Thomas, superintendent.

LEVEES.

During the month of May, 1903, the steamboats were employed to a greater or less extent in levee-protection work, principally at the Hollybrook crevasse and Leland Neck, in levee-inspection service, and returning plant to the fleet.

In April, 1904, the steamer *Arthur Hider* was temporarily transferred from towing stone to levees and used in high-water service for nine days.

The highest stage of water reached this season at Greenville was 43.65, which is 5½ feet below that of 1903, rendering necessary little or no work for high-water protection proper in the third district.

The following is a statement of expenditures in connection with steamboat inspection of levees, levee surveys, and returning floating plant:

1903.			
May.	Services of steamboats at La Grange and Hollybrook crevasses and returning floating plant:		
	Pay roll	$373.35	
	Subsistence	118.43	
	Coal, oil, etc	370.48	
			$862.26
June.	Tug *Parker* and steamer *Arthur Hider* at Hollybrook crevasse and on inspection trip; steamer *Vedette* making survey near Mathews Bend:		
	Pay roll	216.17	
	Subsistence	46.02	
	Coal, oil, etc	134.92	
			397.11

1903.			
July.	Steamer *Arthur Hider* in inspection service and returning plant from Hollybrook crevasse; steamer *Vedette* making general levee survey:		
	Pay roll	$307.02	
	Subsistence	140.61	
	Coal, oil, etc	261.62	
			$709.25
August.	Steamer *Vedette* making levee survey:		
	Pay roll	232.33	
	Subsistence	94.06	
	Coal, oil, etc	144.59	
			470.98
October.	Steamer *Arthur Hider* engaged in inspection trip:		
	Pay roll	106.00	
	Subsistence	41.48	
	Coal, oil, etc	87.93	
			235.41
1904.			
April.	Steamer *Arthur Hider* in general high-water service:		
	Pay roll	386.16	
	Subsistence	88.20	
	Coal, oil, etc	426.98	
			901.34
	Total expended		3,576.35

Cost of repairs to plant, third district, improving Mississippi River, May 1, 1903, to May 1, 1904.

Number or name.	Cost.	Remarks
Steamer—		
Arthur Hider	$1,161.64	General repairs.
Vedette	788.62	General repairs. (Sold at auction Mar. 10, 1904.)
Meter	256.29	Minor repairs. (Sold at auction Mar. 10, 1904.)
Tug Parker	218.72	General repairs.
Quarterboat No. 86	1,896.32	Docked and thoroughly repaired.
Quarterboat No. 88	1,916.41	Do.
Quarterboat No. 155	1,919.72	Do.
Quarterboat No. 156	967.39	Do.
Quarterboat No. 158	2,426.79	Do.
Quarterboat No. 159	1,608.83	Do.
4 quarterboats	1,058.17	Minor repairs.
3 mattress boats	237.95	Do.
Carpenter shop No. 78	2,056.21	Docked and thoroughly repaired.
Machine shop No. 222	2,025.63	Do.
Store boat No. 138	62.21	Minor repairs.
18 square barges	4,090.58	General repairs.
12 square barges (new)	234.13	Salted and sprayed with spirittine.
Grader No. 1	407.04	General repairs.
Skiffs	9.86	Three calked and repaired.
Pumps	137.51	General repairs.
Pile driver No. 49	29.26	Minor repairs.
Floating dry dock	300.19	General repairs.
Calking flats	51.94	Do.
Levees	52.54	Stakes and high-water spikes.
Property	298.10	General repairs.
Surveys	45.17	Making stakes, etc.
Miscellaneous	898.28	Making coal boxes, etc.
Construction	458.94	Making pike poles, capstan bars, etc.
Wages account	2,145.56	Salary and subsistence of cooks, waiters, etc.
Total expended	27,759.00	

The amount expended in repairs, as shown above, was $27,759.

Sufficient plant for one revetment party is now in fair condition. Keeping this portion of the plant in repair will be very much less expensive for the present season than for the last.

The absolutely necessary repairs required for sufficient plant for operating a single revetment party during next season will be:

Rebuilding hull of tug *Parker* and overhauling machinery	$4,500
Repairs to hull of hydraulic grader	2,500
Ordinary repairs during season	5,000
Total	12,000

The above is the minimum amount that will be required under any possible circumstances. Should it be decided upon to put a second revetment party in the field it would be necessary to provide an additional set of mattress ways and mooring barges and repair a few of the old barges for brush and poles.

The estimated cost of these repairs is as follows:

Rebuilding one set of mattress ways	$6,000
Fitting and strengthening two second-class barges for mooring barges	2,400
Repairing six second-class barges for brush and poles	7,200
Repairing two second-class barges for cable and line barges	2,000
Total	17,600
Adding repairs absolutely necessary for first revetment party	12,000
Total estimated cost	29,000

The new steel towboat now being constructed at Jeffersonville for the third district will probably be finished by the middle of June. The progress made in the construction of this boat has been extremely slow, the contractor claiming that the delay is due to the impossibility of getting material.

The new boat, with the 12 new barges recently built and the small steel inspection and survey boat *Unique*, recently purchased, together with the additional repairs to the old plant estimated above, will give the third district sufficient plant to operate two revetment parties at the same time and provide a boat for surveys and inspection service.

The cost of caring for plant and property was $21,867.02.

The average number of men engaged in the service of care and repairs to plant was 48. The average daily cost of subsistence for employees engaged in this work was 31.7 cents.

Respectfully submitted.

Arthur Hider,
United States Assistant Engineer.

Capt. E. W. Van C. Lucas,
Corps of Engineers.

Appendix 2 E.

REPORT OF MR. CHAS. LE VASSEUR, UNITED STATES ASSISTANT ENGINEER, ON LEVEES, UPPER ST. FRANCIS LEVEE DISTRICT, FOR SEASON OF 1903-4.

Memphis, Tenn., *May 1, 1904.*

Captain: I have the honor to make the following report on the levees in the Upper St. Francis levee district and on the work done under my charge in this district during the season of 1903-4.

The Upper St. Francis levee district, which is on the right bank of the river, at the head of the St. Francis Basin, extends from the hills at Commerce, Mo , 35 miles above Cairo, Ill., to New Madrid, Mo., 70 miles below Cairo, and is bounded north and east by the Mississippi River, west and south by a prominent ridge, known as Prairie Ridge, which has a north and south direction, a length of about 100 miles and a width of several miles. This ridge is from 5 to 10 feet above the highest known floods and comes to the river at New Madrid.

The general topographical feature of this district is that of the flat country cut up by swamps and depressions typical to the Mississippi alluvial region. The area subject to overflow is situated between the river and Prairie Ridge, and is about 700 square miles.

This land, though generally low, is separated into sections by several high ridges, Maple, Wolf, Charleston, O'Bryan, Russ, and Walnut, located in the northern part of Mississippi County, and which are above all except the highest floods.

In addition to the above area, a very large part of the St. Francis Basin is subject to overflow from this same water, as it finds its way through the low gap at the upper end of Prairie Ridge. The latter region is also subject to overflow by high water getting through the narrow gap between Cape Girardeau, Mo., and Commerce, Mo., but a small State levee has been built across this gap.

The part of this district situated above Prairie Ridge is drained mostly by St. John Bayou, which has its mouth just above New Madrid. But the part situated between the Mississippi River and Prairie Ridge, being, as stated above, separated into sections by high ridges (see sketch accompanying this report), is divided into one large and several small watersheds, whose natural drainage is entirely controlled by the location of these high lands, thus complicating by the levee construction the drainage problem in this district.

The large separated watershed is situated south of the ridges and drains mostly southward by small depressions, sloughs, and bayous into the Mississippi River through James Bayou. This bayou is the main natural drain. It has its origin in Big Cypress Swamp, located in the northern part of Mississippi County, and empties into the river near the foot of Island No. 7, at the extreme southwest corner of the county, after having formed several big ponds or lakes, namely, Fourmile, Tenmile, Dernida, and Eagle ponds, Muskrat and Grassy lakes. These ponds and lakes constitute a series of natural reservoirs for the drained waters of nearly the whole country.

Of the three small watersheds, one, including the territory lying between the river, Charleston Ridge, and Big Cypress Swamp, is drained into the Mississippi through Fish Lake and Stevenson Bayou, which slopes northward.

Another, including the territory between the river, and Russ and Walnut ridges, is drained into the Mississippi through Brewer Lake, which slopes southward and empties into the river at the southern end of Walnut Ridge.

The third one, including the territory between Russ, Walnut, and O'Bryan ridges and the river, is drained northward through Little Cypress Swamp and partly eastward through Beckwith Swamp.

It may be stated here that the local authorities have organized a drainage commission, whose plan is to utilize the general natural drainage of the country, dredging and keeping them clear of accumulated drift and obstructions, and connecting them by a series of drainage canals. When the plans of this drainage commission shall have been completed, the territory west and south of Charleston Ridge will be drained by Ash and Maple sloughs into St. John Bayou bottom, above New Madrid, Mo., through Eagle Lake, and by Bowe Ditch, Wolf Ditch, and White Pond into Four and Ten mile ponds, through Cross and James bayous.

The territory east of Charleston Ridge, between this ridge and O'Bryan Ridge, will be drained partly northward into Stevenson Bayou through Fish Lake, and partly southward into Ten Mile Pond through James Bayou.

The territory east of James Bayou, between Russ, Walnut, and O'Bryan ridges, will also be drained into Ten Mile Pond by a drain cut through O'Bryan Ridge to Clear Lake, which empties into James Bayou at a point one-half mile north of Henson Station on the Iron Mountain Railroad.

Clear Lake will be relieved of this surplus drainage water by a canal cut from a point in a bend of Clear Lake 1 mile east of its junction with James Bayou, southward to McAlvein at the foot of McAlvein Swamp. This swamp will drain the country immediately south of O'Bryan Ridge.

The territory between the Mississippi River from Birds Point to the outlet of Brewer Lake, Russ and Walnut ridges, is and can possibly be drained only by Brewer Lake. This drainage will be effected by a culvert through the levee, a description of which forms part of this report.

The Upper St. Francis levee district includes three counties, Scott, Mississippi, and New Madrid. The land in these counties is in a high state of cultivation and the farms or plantations are in a very advanced and improved condition. The main crops are wheat, oats, barley, corn, and hay. The low places or swamps are now in active state of exploitation.

Up to the date of this report the jurisdiction of the Mississippi River Commission does not, as far as levees are concerned, go above Cairo. The legal boundary of the district for the United States Government levee work begins at the town of Birds Point, Mo., opposite Cairo, and extends from the railroad embankment at the lower line of the town to New Madrid, a distance of about 70 miles. Above Birds Point levee matters were exclusively under local control until November 13, 1903, when the different levee organizations passed, at a special meeting, a resolution to the effect that the future expenditures of the local boards for levee construction, or work related to levees in general, would be made under the direction of the United States engineer officer in charge of the first and second districts, Mississippi River improvement.

The levee work in this district commenced as early as 1854, when the county court ordered a sale of swamp lands, and about $250,000 were expended in levee construction up to the high water of 1858. In 1892 the levee district No. 1 was organized, and up to May 1, 1903, a levee had been built under this board from Commerce to the Iron Mountain Railroad, a mile above Russ Point. South of this town a levee was started in 1896, but owing to some legal complications the board was compelled to stop work. A private levee, or, more properly speaking, a levee constructed by the landowners, was erected back of Wolf Lake and along the bank of the chute. This levee has a length of about 7½ miles and terminates at a point nearly opposite the foot of Wolf Island.

Since the beginning of levee construction in this district the following amounts were expended on levee work up to May 1, 1903, by the different local organizations and by private subscriptions of landowners:

1854 to 1858, from Commerce to Charleston	$250,000
1882 to 1903, 7½ miles back Wolf Island	20,000
1892 to 1894, from Charleston to Birds Point	85,000
1896, south of Birds Point	7,000
Repairs to levee, high water expense, right of way, etc	10,000
Total expended	372,000

As stated above, the Mississippi County levee district No. 1 was organized in 1892, but on account of some legal irregularities had to be reorganized in 1900. This organization is now in good shape financially and able to do some levee work every year.

The revenues are derived from, first, a tax of 7 mills on the dollar, second, a tax of $1.50 per acre on the benefits to land protected by levee, and, third, by a supplementary tax of 10 mills on the dollar.

By a law of the State of Missouri the district board is authorized to issue $100,000 worth of bonds, which are guaranteed by a special tax of $1.50 per acre to be levied on the benefits that will be received by the lands from the levee construction, these benefits to be fixed by the county board of equalization.

In addition to these, an ad valorem tax on all land in the district is raised for incidental purposes.

This district has also available for the coming fiscal year a sum of $20,000, which has been appropriated by the Missouri general assembly, during its last session, to aid toward the completion of the levees in Mississippi County.

The sentiment of the people in this district is entirely in favor of levees, and, outside of the regular resources of the Board, the United States and State appropriations, many private subscriptions have been made to build and repair the levees, or to be applied to different kind of works which were urgent and necessary for the benefit of the existing embankment.

From Birds Point southward, in the part of the district under the jurisdiction of the Mississippi River Commission, work by the United States was begun in 1899. No work was done between April 30, 1901, and May 1, 1903, by the United States. This was owing to the failure of Congress to pass a river and harbor bill for the year 1901-2, and to the fact that no funds were allotted by the Mississippi River Commission during the fiscal year 1902-3.

The levee built by the United States and the local levee board up to May 1, 1903, was extended for a distance of 5 miles and 2,000 feet below the initial point of the district, situated as described above at the lower limit of the town of Birds Point.

From the funds made available by the sundry civil act of March 3, 1903, the Mississippi River Commission allotted $20,000 for levee work in this district.

The levee work done by the United States between May 1, 1903, and April 30, 1904, was all new work, from stations 5/20 to 6/0 (6 R.) and consisted of 83,325.5 cubic yards of embankment and banquette, 525.3 cubic yards of topping, 5,978.2 cubic yards of excavations, and 171 cubic yards of road crossings, a total of 90,000 cubic yards, at the contract price of 19.5 cents per cubic yard.

This work was constructed to the Mississippi River Commission standard grade and cross section.

Including office and engineering expenses the actual cost of the above-named work was 22.20 cents per cubic yard.

In addition to the above work by the United States, the local board since May 1, 1903, constructed a levee 2,200 feet in length, from the south end of the existing levee from Charleston to Bird Point, toward the north end of the United States levee below town; also, in conjunction with the Government, erected about five stations of the levee from 5/20 to 6/0. The local board work is shown in the following table:

Location.	Miles below Cairo.	Yardage.	Price per cubic yard.	Remarks.
		Cubic yards.	*Cents.*	
Bird Point, Mo	0	49,879.0	16.0	Completed, new work.
5/20 to 6/0	6	5,103.5	19.5	Not completed.
Total	....	54,982.5	....	

This local board work was constructed under United States specifications and the superintendence of United States inspector.

The cost of this work was $8,975.80.

During the period from May 1, 1903, to April 30, 1904, earth was added to the levee in the part of this district under the Mississippi River Commission jurisdiction, as follows:

	Cubic yards.
By the United States	90,000.0
By the local levee board	5,103.5
Total	95,103.5

None of the existing levee was lost or abandoned during this season on account of caving banks or from other causes.

The following is a summary of the earth in the levees of this district from the lower limit of Birds Point south:

	Cubic yards.
Put up by the United States and in place April 30, 1903	287,198
Added from May 1, 1903, to April 30, 1904	90,000
Total by the United States	377,198
Put up by the levee board and in place April 30, 1903	98,700
Put up by landowners back of Wolf Island and in place April 30, 1903	180,000
Added from May 1, 1903, to April 30, 1904	5,104
Total	283,804
Levee in place April 30, 1904:	
Erected by the United States	377,198
Erected by local authorities and others	283,804
Total in place	661,002

The extension of the levee southward during the fiscal year cut off the drainage of one of the small independent basins situated between the Mississippi River from Birds Point to the outlet of Brewer Lake, Russ and Walnut ridges, which, as stated above, can be drained only through Brewer Lake.

The local authorities decided to construct at the foot of Brewer Lake a culvert through the levee to drain this watershed.

Preliminary examinations, projects, plans, and specifications for such structure were made in this office under your direction.

The area of Brewer Lake watershed is about 12 square miles, 8,000 acres. About two-thirds of this territory is under cultivation, and from the data collected and analyzed in my report dated January 8, 1903, Brewer Lake, used as a reservoir, was called upon to store 110,000,000 cubic feet of rain water.

Brewer Lake has a length of about 7½ miles; its average section available for storage is 2,850 square feet, and its storage capacity about 104,000,000 cubic feet. The lake was thus found insufficient to take care of the drainage water from the whole watershed during the maximum duration of the high-water period.

The culvert was to be designed so as to discharge the accumulated maximum drainage water in about fifteen days, with a flow of water through it of not over 10 feet per second, which represents a discharge of 85.61 cubic feet per second.

Plans of different forms and modes of construction were submitted by this office to the Mississippi River Commission. The plans for a steel-concrete culvert were adopted September, 1903, and work on this structure was begun by the levee board December 15, 1903.

This culvert, of which plans and detail drawings are herewith transmitted, is a conduit 120 feet long, having two chambers 36 inches in diameter. The inlet and outlet of this conduit are provided with retaining and wing walls. The outlet has a concrete floor apron and the spillway is to be revetted with riprap to prevent scouring. Corrugated steel bars three-fourths and one-half inch square are used as forms and reenforcement for the conduit, which is entirely of concrete in the proportion 1, 2, and 6, Portland cement, sand, and gravel. The chambers are revetted with a one-half inch cement wearing coat, which is built simultaneously with the concrete filling. This wearing coat is in the proportion of 1 and 2. The retaining and wing walls are of concrete of the same proportions as for the conduit, reenforced with three-fourths and one-half inch corrugated steel bars placed as indicated on drawings.

This structure rests on cap pieces of cypress 8 inches square, driftbolted to piling 10 inches in diameter, having a penetration of 16 feet and placed 5 feet apart. Every 10 feet along the conduit concrete rings 1 foot wide are projecting 6 inches from the surface of the main structure. The whole mass is bedded and inclosed in puddled clay to prevent any percolation of water along the conduit. The retaining and wing walls are backed up also with puddled clay.

For the closure of the conduit, flap valves are adopted. These are hinged to cast-iron pipes one-half inch thick, 36 inches in diameter, projecting 4 feet from the face of the wall and encased 6 feet in the concrete masonry of the conduit.

The natural ground through which the culvert is built has a layer of fine sand about 3 feet thick, beginning 1 foot above the top of the piling. This necessitated, to prevent the free percolation of the water through this stratum of sand under the levee at the culvert site, the construction of a wall or core of puddled clay and spalls extending 100 feet each way from the axis of the culvert, just back of both retaining walls.

The elevation of the inlet ditch is 306.3 feet, Memphis datum, 3 feet above that of the low-water surface in this lake, and elevation of the spillway, 303.5 feet.

The levee over the culvert is to be built with a banquette between the retaining walls and will be of the Mississippi River Commission standard grade and cross section.

The levee line crosses the natural outlet of Brewer Lake 500 feet above the culvert. The embankment across this outlet has a fill of 32 feet and is built to standard section and height with a banquette, 8 feet below its crown, of adopted dimensions.

The construction of the culvert at the time of this report is not entirely completed. The river-side retaining and wing wall is yet to be finished. This work was begun December 15, 1903, and had to be suspended during nearly the whole winter on account of bad and freezing weather. At the end of March, the work had just been resumed when it had to be stopped again on account of high water.

It is estimated that the cost of the culvert proper will not exceed $7,500.

In addition to this culvert as a main drain, the drainage of the Brewer Lake watershed will require several lateral ditches to be dug on the east side of the lake to facilitate the complete drainage of the territory occupied by White Pond. These ditches are now very important for the land east of the lake, and ought to be excavated as soon as practicable, the extension of the levee during this fiscal year having cut off the small depressions through which part of the drainage of this territory was finding its way to the river. For this reason the backwater accumulated during the April flood will remain longer than after previous floods on the land east of Brewer Lake, and might be the cause of complaints from the landowners of this section of the district, who certainly will not understand the real cause of the retarded drainage of the backwater.

The lateral canals or drains will also be a benefit to the general drainage of the Brewer Lake basin, as they will increase the storage capacity, acting as lateral reservoirs.

The work done by the United States from stations 5/20 to 6/0, also the levee board embankment work over the culvert, was under contract with the Shutt Improvement Company.

These contractors have prosecuted their contract in a very unsatisfactory manner. The contract was let in March, 1903, and, notwithstanding the late high stage of the water, the Shutt Improvement Company could have begun operations at the end of June or early in July. They only started on the work in the middle of October, and the labor force has been since entirely insufficient. Practically since the end of

February the contractors had no force whatever on the work, and now for the last month not even a representative ot the company, not to speak of any outfit, is on the ground.

On March 28, when the gauge at Cairo was 43 feet, preparations were made for the protection of the levees in the district during the coming flood.

The high-water protection work was in charge of United States inspector George de Beughem, but all expenses were borne by the levee board.

The maximum reach by the spring flood was 49.2 feet on the Cairo gauge, and the water stood against the levees an average of 1 foot below the 1903 high water.

A protection levee 200 feet in length was constructed in front of the culvert to prevent the flow of water over the unfinished work. This levee contains about 800 cubic yards and acted successfully; but as the river was rising the seep water behind this embankment came up into the unfinished part of the culvert, and to protect it from any damage the ground between the protection levee and the inlet retaining wall was flooded, thus forming a pond of dead water. This has proved to be a good measure, as, when the water subsided, the culvert was found not to have suffered in any manner from the flood.

Several places along the levee had to be protected with sacks, and at the end of the new levee a spur made of sacks and brush successfully prevented any loss of embankment.

The cost of the high-water protection work was, including the protection levee in front of the culvert and the work done on the levee at Birds Point, built this year by the levee district, $450. This sum was paid by the local board and the United States furnished only 5,000 sacks.

A profile showing the high-water elevation and the exact location where work has been done on the levee during this flood is transmitted with this report.

It is estimated that the acreage covered by the last overflow in this district is nearly equal to that covered by the 1903 flood—that is, from 160,000 to 170,000 acres.

The work in the Upper St. Francis levee district proposed to be done next fiscal year is as follows:

From stations 6/0 to 6/19, 40,000 cubic yards of new work, in continuation of the levee from Birds Point to Brewer Lake. This work will be done under the supervision of this office, but will be paid by the levee board.

From stations 10/35 to 15/38, 120,000 cubic yards of new work, from O'Bryan's Ridge to Crosno. This work will be done by the United States.

From stations 15/38 to 18/44, 83,000 cubic yards of new work, from Crosno to the north end of the existing State levee back of Wolf Island. This work will be done under the supervision of this office, but will be paid for from funds raised by the landowners of the adjacent territory.

In addition to this it is more than probable that from ten to fifteen thousand dollars' worth of levee work will be done during the coming season by the levee board, under United States supervision, extending southward the State levee from its south end opposite the foot of Wolf Island.

After this work shall have been constructed, a total of 4,558,650 cubic yards additional will be required to complete the levees in this district, the cost of which is estimated at $592,600.

Before closing this report I will state that in this district the United States law for the protection and preservation of work built by the United States is well observed by the people. As soon as copies of the law, in accordance with your instructions, were posted along the levee line, all trespassing on the embankment ceased and all fences and other obstructions were removed from the levees. Several buildings are yet located on the right of way, but the local board is proceeding to obtain legal rights to order their removal.

The following inclosures accompany this report and form part of it:

Map showing the drainage of Mississippi County, Mo.
Plans and drawings of Brewer Lake culvert.
Map and profile of this fiscal year's levee work.
Profile of high-water elevation and high-water protection work.
Profile of the work proposed to be done during next fiscal year.

Respectfully submitted.

Chas. Le Vasseur,
Assistant Engineer.

Capt. E. W. Van C. Lucas,
Corps of Engineers.

APPENDIX 2 F.

REPORT OF MR. CHAS. LE VASSEUR, ASSISTANT ENGINEER ON LEVEES IN REELFOOT LEVEE DISTRICT DURING THE SEASON OF 1903-4.

MEMPHIS, TENN., *May 1, 1904.*

CAPTAIN: I have the honor to make the following report on the levees in the Reelfoot district, and on the work done under my charge, during the season of 1903-4.

The Reelfoot levee district, which is on the left bank of the river, lies at the head of the Reelfoot Basin. This basin is bounded on the north and east by the line of bluffs extending from Columbus, Ky., to Memphis, Tenn., on the west by the Mississippi River, and on the south by the Obion River, which empties into the Mississippi at a point some 100 feet below Hickman, Ky. Its average width is 12 miles. In this basin is situated a part of Prairie Ridge, which has its origin in the Upper St. Francis district on the right of the river and which has been cut through by the river at New Madrid, Mo. (70-R). This Prairie Ridge is, in this basin, about 20 miles long, forms the river bank for many miles, and, by its location between Reelfoot Lake and the river and its elevation well above the highest flood, acts as a natural levee. This natural topographical feature, with the construction of the levees in the Reelfoot levee district, will practically protect the greater part of the basin.

This levee district was created by a resolution of the Mississippi River Commission passed at is session of November, 1900. It extends from the bluff at the city of Hickman, Ky., to the highland near Slough Landing, Tennessee, a distance by river of 24 miles. The length of the levee, when completed, will be about 21 miles.

The area that will be protected by this levee includes the entire bottoms of Reelfoot Lake and contains about 310 square miles.

Two local boards are in this district—one for the territory situated in Kentucky, known as the Fulton County levee board; the other for the territory situated in Tennessee, known as the Lake County levee board. About 16 miles of the levee line are located in Fulton County, Ky., and the remaining 5 in Lake County, Tenn.

It is estimated that about 175,000 acres of overflowed lands will be reclaimed by the building of the levees in this district. Only about 25,000 acres, or one-seventh of the entire acreage, are in Kentucky, the remainder being in Lake, Obion, and Dyer counties, Tenn.

In 1901 the citizens of Fulton County, Ky., organized a provisional board of levee commissioners. In 1903 this organization was legally recognized by the Kentucky legislature.

By the terms of the constitution of the State of Kentucky the Fulton County levee board is permitted to vote and collect each year a tax of not exceeding 50 cents on the $100 worth of property in the territory to be reclaimed for all purposes. In view of the fact that only about 25,000 acres of, at present, low-priced lands could be taxed, the Fulton County levee board can not realize more than $500 per year from taxation. Hence this board decided it best to depend upon voluntary donations for the present, or until, from the enhanced value of the overflowed lands, a larger sum could be realized from taxation.

In this way the board has secured voluntary donations from the landowners in the county sufficient to acquire the entire right of way for the 16 miles of levee in Kentucky, to pay the damage to crops occasioned by the building of the levee, to build about 2 miles of embankment, and to repair the United States Government levee materially damaged by the 1903 flood.

During the fiscal year the board expended the sum of $14,835.55 on levee work, which will be described below, and expect to raise from five to eight thousand dollars for work to be done during next season.

All the work done by the Fulton County levee board is done under the supervision of this office and in accordance with the United States specifications.

The Lake County levee board was organized during the beginning of the fiscal year 1900-1901. The jurisdiction of this board extends from the Kentucky-Tennessee State line to Slough Landing. This board has no annual income. The funds used in the building of the 4½ miles of levee by this organization during last fiscal year were derived from the sale of $100,000 6 per cent 10-50 year bonds. Of these funds there remains $17,000 now in the hands of the board, which will be expended on levee work as here below described.

There is no levee tax in this county except to pay interest on the bonds above mentioned, and when the board will have expended the $17,000 left there will be no revenue to be applied to levee construction or maintenance, not to speak of high-water protection work.

In the Reelfoot district levee construction work by the United States was begun during the fiscal year 1902-3 and was extended for a distance of 2 miles 1,000 feet below the initial point of the district, situated, as described above, at the foot of the bluff at the town of Hickman, Ky.

From the sundry civil appropriation act of March 3, 1903, the Mississippi River Commission allotted $20,000 for levee work in the district.

The levee work done by the United States between May 1, 1903, and April 30, 1904, was all new work from stations 4/0 to 5/33 (39 L.), and consisted of 895,682 cubic yards of embankment and banquette, 1,587.3 cubic yards topping, 21,711.1 cubic yards of excavations, 782.8 cubic yards of road gap, making a total of levee work done of 113,749.4 cubic yards, at an average contract price of 14.45 cents per cubic yard.

All the above levee work was constructed to an elevation about 2 feet below the established Mississippi River Commission levee grade, with a topping 1 foot below this established grade.

Including office and engineering expenses and contingencies the actual cost of the above-named work was 15.57 cents per cubic yard.

In addition to the above work by the United States, the Fulton County levee board, since May 1, 1903, repaired the 2 miles of levee built by the Government in 1902-3 and constructed about 2 miles of new levee. The work done by this board is as follows: Stations O to 2/7 (37 L.), 4,060 cubic yards of repair work; stations 2/7 to 4/0 (38 L.), 101,000 cubic yards of new work, a total of 105,060 cubic yards.

This local board work was constructed under United States specifications and under the superintendence of the United States inspector.

The cost of this work was $14,835.55.

The new work, from stations 2/7 to 4/0, was built to an elevation 2 feet below the established Mississippi River Commission grade, with a topping to 1 foot below this established grade.

In the Lake County levee district during the period from May 1, 1903, to April 30, 1904, no work was done.

From May 1, 1903, to April 30, 1904, earth was added to the levee in the Reelfoot levee district as follows:

	Cubic yards.
By the United States	113,749
By the Fulton County levee board	105,060
Total	218,809

During the April flood, as will be reported below, about 2,300 cubic yards of the work done this fiscal year by the United States was lost at the end of the levee, station 5/31, and about 600 linear feet of the levee built by the Lake County levee board in 1902-3 were washed away at the north end, representing a loss of about 10,000 cubic yards.

None of the existing levee was lost or abandoned during this season on account of caving banks or from other causes than that just mentioned. The following is a summary of the material in the levees of this district:

	Cubic yards.
Put up by the United States and in place April 30, 1903	141,912
Added from May 1, 1903, to April 30, 1904	113,749
Total	255,661
Less amount lost during the 1904 flood	2,300
Total in place built by the United States	253,361
Put up by the Lake County board and in place April 30, 1903	440,710
Added from May 1, 1903, to April 30, 1904, by the Fulton County levee board	105,060
Total	545,770
Less amount lost during the 1904 flood	10,000
Total in place built by the local boards	535,770
Levees in place April 30, 1904:	
Erected by the United States	253,361
Erected by the local boards	535,770
Total in place	789,131

The levee work done by the United States from 4/0 to 5/33 was done under contract with M. J. Roach. This work was prosecuted with diligence and completed on September 12, 1903, in a satisfactory manner with the exception of the last stations, which, on final inspection, were found slack in cross section and put up with less care than the balance of the contract. A certain quantity was deducted for the slack in cross section, and the dressing of these stations was done over by the local levee board contractor for M. J. Roach.

The levee work done under the Fulton County board was constructed by Outzen & Co., and has been put up to the entire satisfaction of the Government.

When the embankment work done by the United States from 4/0 to 5/33 was completed, it was decided to protect the end of the levee at station 5/33 with a revetment to prevent damage to it from erosion action of the overflow water.

This protection work consisted in a barricade made of logs, brush, and sacks filled with earth. A plan of this work accompanies this report. The cost of the barricade was $375.

The levee work in this district was done during the past season under the direct supervision of United States Inspector Fred Wigstrand.

On March 26, 1904, when it became apparent that the river would reach a high stage, preparations were begun for the protection of the levee against the flood. United States Inspector P. M. Lohman was sent in charge of the high-water work, but was relieved a few days later by Mr. W. A. McTighe.

The maximum elevation reached by the spring flood was, along the levees in this district, about 0.7 below that of 1903 flood.

The barricade protecting the end of the levee acted well and has not been undermined by the flood water; but 200 feet above it, on the land side of the levee, a pile of logs and driftwood was situated about 25 feet from the foot of the slope, the current of the backwater flowing along the levee, when, encountering this obstruction, it was deflected against the embankment and succeeded, notwithstanding the construction of dikes, sack cribs, and revetment, in breaching it. It was thought for several days that the high-water protection work at this locality had been efficient to prevent a break, but on April 5, when the river had attained its maximum, the levee, where previously breached, caved in to a width of about 70 feet. The ends of the crevasse were immediately revetted with sacks, and further enlargement of the gap was successfully stopped. This gap had attained a width of about 150 feet, but no hole was created by the crevasse. It is believed that the cave of the embankment was due to faulty construction at this place, as when it occurred stumps and logs were observed to have been left under the levee embankment.

Several small seeps along the levee were revetted with sacks and brush, but did not cause apprehension at any time.

In Lake County the current of the flood water undermined and washed away about 600 feet of embankment at the north end of the levee built by this board in 1902-3. The local board of this county assumed charge of the high-water protection work, and at the time of this report the exact cost of the work could not be ascertained.

The cost of the high-water work on the Fulton County front was $597.20, paid by the United States and $110.50 paid by the board. The Government furnished 3,000 sacks.

A profile showing the high-water elevation and the exact location where work has been done on the levee during this flood is transmitted with this report.

This district during the flood did not receive much protection from the existing levees. The water coming through the 10-mile gap between the two ends of the levee overflowed about the same area as in 1903 (about 300 square miles). The only benefit was received by the land in the upper end of Fulton County. The backwater reaching only to station 4/40 on the levee, the land above this point could be cultivated during the flood.

The proposed work in the Reelfoot levee district to be done next fiscal year is as follows:

From 5/33 to 7/0 and from 8/0 to 8/45, 120,000 cubic yards of new work, in continuation of the work done this fiscal year, will be done by the United States.

The Fulton County board expect to do, from 7/0 to 8/0, 42,000 cubic yards of new work under the office supervision of this office.

The Lake County board will repair the damage done to their levee by the flood and extend the levee northward to the State line. This board assumes all supervision of their work, which is done entirely independent of this office.

When this work shall have been constructed, a total of 1,300,000 cubic yards will yet be required to complete the levee in this district. This amount will cost probably $195,000.

The United States law for the protection and preservation of the levees is well observed in the Fulton County district, where, immediately after copies of said law were given to the local authorities and posted along the levee, the local board proceeded in the removal of fences and other obstructions.

It is not the same in Lake County, where trespassing on the embankment is reported to be a usual occurrence.

The following inclosures accompany this report and form part of it:
Map showing the location of the levees in the Reelfoot district.
Plan of the barricade erected at station 5/33.
Profile of high-water elevation and high-water protection work.
Profile of the work proposed to be done during next fiscal year.

Respectfully submitted.

CHAS. LE VASSEUR,
Assistant Engineer.

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

Detail statement of work done on and condition of Reelfoot levee during high water of April, 1904.

Station 2/10: At base of levee, land side, 50 sacks used to fill mud boil.

From station 3/35 to 3/40: Levee washing at base on river side; protected by sacking.

Station 3/46: At base of levee, land side, 75 sacks used to fill small wash.

Station 5/11: At base of levee, land side, 20 sacks used to fill boil.

From station 5/23+40 to 5/25: Levee washing at base, river side; crossing at station 5/23+52 washed away on river side; protected by sacking.

From station 5/26+04 to 5/27+96: Levee washing at base; sacked.

From station 5/27+96 to 5/32+36: Levee washed away; 2,055 sacks used from station 5/26+04 around upper end washout to prevent further washing.

Tabulated statement of high-water elevations from milepost 0 to milepost 5, Reelfoot Lake district, high water, April, 1904.

Mile.	Elevation high water, riverside.	Elevation backwater, land side.
Milepost 0	....	....
Milepost 1	310.89	....
Milepost 2	310.66	....
Milepost 3	310.59	....
Milepost 4	310.54	....
Milepost 5	309.89	306.70

The backwater reached only to station 4/40.

NOTE.—The elevations are referred to the Memphis datum.

APPENDIX 2 G.

REPORT OF MR. A. F. KILPATRICK, UNITED STATES ASSISTANT ENGINEER, ON LEVEES, LOWER ST. FRANCIS LEVEE DISTRICT, FOR SEASON 1903–4.

MEMPHIS, TENN., *May 1, 1904.*

CAPTAIN: I have the honor to submit the following report of operations on levee work in the Lower St. Francis levee district for the year ending April 30, 1904:

This district (79 to 298 miles below Cairo, R.) extends from the high lands about 9 miles below New Madrid, Mo., to the mouth of the St. Francis River in Arkansas, a distance of 219 miles by river. When completed, its length by levee line will probably be about 210 miles, and the area protected will be about 3,500 square miles. (For further descriptions see supplement to Report of Chief of Engineers, 1902, p. 95.)

At the beginning of the year there were five incompleted contracts in force, as follows:

Station.	Miles below Cairo.	Cubic yards in place.	Cubic yards to be placed.	Total.	Price per cubic yard.
					Cents.
0/52–1/5+17	79 R.	4,383.0	1,103.0	5,485.0	14.45
11/0–15/0	92 R.	7,956.7	145,149.0	153,105.7	15.00
29/23–31/5	112 R.	79,927.1	40,144.2	120,071.3	15.00
46/15–47/31	128 R.	49,926.5	110,517.2	160,443.7	15.00
122/0–127/28	208 R.	128,933.7	21,707.3	150,641.0	14.00
Total	....	271,126.0	318,620.7	589,746.7	....

Of the above contracts, that from stations 11/0 to 15/0 is still in force, incompleted on account of unusual weather and high water conditions, on which 135,105.7 cubic yards are in place, with 18,000 cubic yards yet to be placed. The contract for stations 0/52 to 1/5+17 was terminated owing to failure of the local levee board to obtain right of way, and was subsequently completed by hired teams. That for stations 29/23 to 31/5 was also completed by hired teams during the present year.

From the allotment of $125,000 made from the appropriation for the year 1903–4 the following work has been done:

Station.	Miles below Cairo (right).	Cubic yards in place.	Price per cubic yard.	Cost.	Cubic yards to be placed (about).	Total (about).
			Cents.			
8/0–11/0	85	96,032.5	16.48	$15,826.16	....	96,032.5
15/0–17/0	95	68,554.3	17.00	11,654.23	8,945.7	77,500.0
28/34+65 to 29/40+35	111	118,458.7	14.00	16,584.21	....	118,458.7
51/0–51/42	135	26,905.1	13.98	3,762.13	....	26,905.1
83/44–83/51	168	7,996.5	14.70	1,191.48	....	7,996.5
127/28–134/0	213	51,133.3	16.94	8,661.99	178,866.7	230,000.0
Drain ditch on mile 131	210	1,894.8	25.00	473.70	3,105.2	5,000.0
Total	....	370,975.2	....	58,153.90	190,917.6	561,892.8

The average construction price will be about 17.4 cents per cubic yard. Of the above, the contract for stations 15/0 to 17/0 is yet in force, the contractor having been unable to complete on account of unusually bad weather, labor, and high-water conditions. A contract for enlarging the levee from stations 5/0 to 8/0 was also awarded, but the work had not been commenced in August, 1903, when, on account of the rapidly caving bank at Caruthersville, Mo., it became evident that a new levee would have to be constructed from stations 28/34+65 to 29/40+35. In order to do this, with funds available for the district, it became necessary to cancel the contract from stations 5/0 to 8/0, and make an informal one on the new work from stations 28/34+65 to 29/40+35. On this account the contractor who built the new levee was granted an extension of time on his enlargement work from stations 127/28 to 134, and also on the informal drain-ditch contract in front of mile 131. The remaining informal contract (for stations 83/44 to 83/51), for a short, new levee back of the badly washed old one, was made late in 1903, when it developed that sufficient funds were available.

On the unfinished contracts of the previous year there was expended for hired teams:

On contract from stations 29/23 to 31/5	$2,893.75
On contract from stations 0/52 to 1/5+17	691.00
Making a total of	3,584.75

Team repair work was also done on miles 45, 49, and 53, amounting to $317, making a grand total cost of team work $3,901.75. This sum, added to the $58,153.90 expended on construction, makes a total expenditure of $62,055.65, at an average contract price of 16.63 cents per cubic yard.

Of the $125,000 allotted for levee work in the district, the sum total expended from May 1, 1903, to April 30, 1904, including construction, engineering expenses, contingencies, surveys, etc., was $116,184.07, at an average price of 31.14 cents per cubic yard.

WALNUT BEND.

The balance of the funds available for the repairs, protection, and extension of Walnut Bend levee May 1, 1903, was $88,713.94. Of this sum, $2,096.55 was expended under an informal contract in repairing and building a spur levee from stations F/32+20 to F/51, containing 13,977 cubic yards, at a construction price per cubic yard of 15 cents. Including construction work, engineering expenses, surveys, and contingencies, the sum total expended was $2,413.85, bringing the average price per cubic yard to 17.27 cents.

For the year ending April 30, 1903, the contract for stations 11/0 to 15/0 is still in force, with 18,000 cubic yards to be placed.

The contracts yet in force for the year ending April 30, 1904, are as follows: Stations 15/0 to 17/0, 127/28 to 134/0, and drain ditch on mile 131, on which there are to be placed about 191,000 cubic yards, making a grand total of about 209,000 cubic yards yet to be placed.

HIGH-WATER MAINTENANCE.

About the end of march, 1904, it became evident that a flood stage would soon be reached in this district, and, in obedience to your instructions, I went to Caruthersville, Mo., assumed charge of U. S. steamer *Abbot* and crew and effected an organization to protect the levee from Point Pleasant, Mo., to Barfield, Ark. The distance of 56 miles, by levee, was divided into three equal parts. An inspector was placed in direct charge of each part, who, with one or more assistants, constantly traversed the levee in search of weak places, with full authority to take all steps necessary for its protection. The local levee authorities also placed watchmen who walked over the levee day and night during the high-water period, which lasted from about April 3 to 12.

I remained on the steamer *Abbot*, plying the river between Point Pleasant and Barfield, giving instructions to and receiving reports from each inspector daily. Before the water reached a dangerous stage, small levees were built across depressions in the bank at the upper end of the system, where about 1,500 feet of the levee had caved into the river.

No other work was necessary until on the night of April 8, when, owing to a severe windstorm, the levee became badly wave washed at stations 35 to 40, on mile 37; 25 to 30, on mile 41, and 18 to 40, on mile 42. Each of these places was exposed and the bermuda sod had been destroyed by weeds and hogs. The levee was only slightly injured at many other places. The storm lasted from about 7 p. m. on the 7th till 4 p. m. on the 9th, during the greater part of which time the steamer *Abbot* was windbound on the Tennessee shore.

On mile 37 the landowners did some protection work with brush and plank, and on miles 41 and 42 United States Inspector W. H. Gowen, with a United States force, placed 220 sacks of earth. Some unnecessary work was also done by local authorities on mile 55 after the storm was over.

The water reached its highest stage on April 8, when the Cottonwood Point, Missouri, gauge read 38.15 feet, or 1.85 feet lower than the highest previous record. The flood height of water against the levee was ascertained and recorded on each mile.

Including labor, material, team hire, steamboat, engineering expenses, etc., the total sum expended for maintenance on the 56 miles was $1,500.30, or about $26.80 per mile.

Respectfully submitted.

A. F. KILPATRICK,
Assistant Engineer.

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

APPENDIX 2 H.

REPORT OF MR. CHAS. LE VASSEUR, ASSISTANT ENGINEER, ON CONSTRUCTION OF TRAINING WALL IN SECOND DISTRICT DURING THE SEASON OF 1903-4.

MEMPHIS, TENN., *May 1, 1904.*

CAPTAIN: I have the honor to make the following report on the construction of the training wall on mile 16 in Lower St. Francis levee district, decided upon and begun during the present season.

The object of the construction of this training wall was to protect the levee below it from being cut or undermined by the current of the overflow water along the embankment during the high-water period.

During the flood of 1897 the levee from stations 15/42 to 16/10 was badly washed by the eddy and current due to the angle made in the embankment at 15/35+64 and to the head created by the sudden change of direction in the levee alignment. Stancil Bayou runs close and parallel to the levee, and the current along this stretch of levee is very strong during flood time. For these reasons three spur dikes were constructed during fiscal year 1899-1900, at a cost of about $4,000. These dikes were dirt embankments, having regular levee cross section, constructed from the levee to the edge of the bank of Stancil Bayou. The ends of these dikes were protected by plank revetment.

During the 1903 high water the effect of these dikes has been beneficial to the levee, deflecting the current of the overflow water from the levee. But the end revetment has been partially destroyed by the current, and the dikes in their present condition are not offering sufficient protection.

After a special inspection of the locality and a careful examination of the conditions, it was decided to adopt the mode of construction described below.

As shown on the accompanying map, 300 feet above spur No. 1 is a slough, which during high water enters into Stancil Bayou and creates a large whirl, which has undermined the bank just at the foot of spur No. 1. To obviate this the training wall will be erected from station 15/35+64 on the levee to the bank of Stancil Bayou, at a point 150 to 200 feet above the end of spur No. 1, amounting practically to a prolongation of the levee line above the angle of station 15/35+64.

This training wall will, it is expected, throw the main current of Stancil Bayou against the lower bank at the mouth of the slough and cause erosion of the east bank by the energy of two currents, that of the slough and of the bayou, thus forming a new and wider channel farther away from the levee.

The east bank of Stancil Bayou, between spurs Nos. 2 and 3, has shown result of active caving, which must have occurred during the 1903 flood. This caving has certainly progressed during the flood of this spring, and will increase very materially if the bank from the slough to spur No. 2 is caused to cave eastward by a deflection of the current.

The plan for this training wall accompanies this report. It consists of a plank wall made of vertical plank 2 by 12 inches, well driftbolted to waling crosspieces secured to piling placed 8 feet apart. The plank wall will extend 5 feet below the surface of the ground. The construction of such a structure is very simple, and material was secured in the vicinity of the work.

During March, 1904, a proposition made by C. J. Wagner, contractor, to erect this training wall for the sum of $1,074 was accepted. The material will be furnished by the United States. The piling and lumber are already on the ground and work will be resumed as soon as the stage of the river will permit.

With this training wall in place, the three spur dikes would be left in their present condition, without further repairs.

This locality would have been a favorable one in which to build curve levee similar to that built in the Upper Yazoo levee district, section 36/37, but the levee, in its present location, is under contract for enlargement, and the ground in the rear is very low. The construction of a curve levee, not taking into consideration the cost of the levee which would have to be abandoned, would certainly be much more expensive than the erection of the training wall.

The following inclosures accompany this report and form part of it:

Map showing the location of the levee on miles 16 and 17, Lower St. Francis levee district.

Plan of training wall at station 15/35+64.

Respectfully submitted.

CHAS. LE VASSEUR,
United States Assistant Engineer.

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

APPENDIX 2 I.

REPORT OF MR. M. GARDNER, UNITED STATES ASSISTANT ENGINEER, ON LEVEES, UPPER YAZOO LEVEE DISTRICT, FOR SEASON 1903-4.

MEMPHIS, TENN., *May 1, 1904.*

CAPTAIN: I have the honor to submit the following report of operations in the Upper Yazoo levee district for the year ending April 30, 1904:

This district extends from the bluffs just below the Tennessee-Mississippi State line (244 L.) to the Bolivar-Coahoma County line (365 L.), and has 124 miles of levee and protects 3,281 square miles. At the beginning of the year there was one of the 1902-3 contracts still in force, the contractors being unable to complete it on account of the unusual weather conditions and high water.

This contract was for a new loop in the vicinity of Malones Landing (356 L.), from stations 118/10 to 120/11, and amounting to 370,544.5 cubic yards, of which amount there had been put up to May 1, 1902, 128,947 cubic yards, leaving a balance of 241,597.5 cubic yards to be put up during this year, which was completed March 7, 1903.

There is a contract of the 1903-4 work for 300,000 cubic yards still in force, of which amount there has been put up to date 132,255.6 cubic yards, leaving a balance of 167,744.4 cubic yards. The cause of this contract not being completed on time is that the forces of the contractors were moved from this work to do some more urgent work in the third district.

During the year earth has been added to the levee as follows:

	Cubic yards.
By the United States	373,853
By the levee board	1,333,891
Total	1,707,744

There was abandoned during the year on account of caving bank 20,627 linear feet of levee, amounting to 490,000 cubic yards.

The following is a summary of earth in the levees in this district:

	Cubic yards.
Put up by the United States and in place April 30, 1903	6,243,933
Added from May 1, 1903, to April 30, 1904	373,853
Total	6,617,786
Put up by the levee board and in place April 30, 1903	14,628,945
Added from May 1, 1903, to April 30, 1904	1,333,891
Total	15,962,836
Levees in place April 30, 1904:	
Put up by the United States	6,617,786
Put up by the levee board	15,962,836
Total	22,580,622
Deduct for levee abandoned on account of caving banks	490,000
Leaving in place April 30, 1904	22,090,622

The United States put up during the year 373,853 cubic yards at a cost of $65,303.41, or an average price per cubic yard of 17.46 cents, without office and engineering expenses. The total amount of money expended during the year, including office and engineering expenses and contingencies was $75,779.13, making the final cost of earth put up 20.27 cents per cubic yard.

The levee board has constructed, repaired, and enlarged the following levees:

Location.	Miles below Cairo.	Kind of work.	Remarks.
7/20-10/0	253 L.	Enlargement	
12/11-14/15	256 L.	New	
14/15-15/19	257 L.	Enlargement	
16/17-19/0	260 L.	do	
21/0-22/27	264 L.	do	
27/0-29/0	274 L.	do	
35/40-36/1	277 L.	New	
77/32-79/0	319 L	Enlargement	
Miles 83 and 84	333 L.	New	This is a cross levee between the front and back levees. Not completed.
111/0-111/20	339 L.	Enlargement	
113/0-113/33	340 L.	do	
114/0-115/12	352 L.	do	
116/15-117/0	353 L.	Topping	
112/11-122/14	357 L.	Enlargement	Not completed.
122/48-124/2	358 L.	do	

The total cubic yards put up by the levee board amounts to 1,333,891, at a cost of $268,023.79, or 20.93 cents per cubic yard, without office and engineering expenses.

The following is a statement of expenditures of the levee board during the year:

Earth work	$268,023.79
Levee maintenance	79,765.09
Engineering expenses	15,371.78
Right of way	26,768.69
Lawyer's salary	1,800.00
Salaries	3,399.96
Mileage and per diem for levee board members	765.65
High-water expenses	9,000.00
General	4,898.17
Total	409,793.13

The amount expended by the local board, including construction, maintenance, engineering expenses, and right of way was $409,793.13, making a final cost of 37.21 cents per cubic yard.

In the construction of the Malone levee the contractors used, for the first time on the lower Mississippi River to my knowledge, Era graders pulled by traction engines. The grader elevates the earth with an endless belt and loads it into dump wagons.

These wagons when well loaded hold 40 cubic feet. There were four engines engaged in this work, ranging from 18 to 27 horsepower. The 18-horsepower engine appeared as efficient as the larger ones. The first cost of an outfit of this kind is less than one of wheel scrapers and teams of usual capacity, and the maintenance and operating expenses less. The capacity of one engine and grader and 10 wagons is 20,000 cubic yards per month of twenty working days under ordinary working conditions, with a haul not too long for 10 wagons to keep the engine busy. Of course the longer the haul the more wagons can be used behind an engine.

The experience at Malones does not bear out the above figures, but there were some good reasons for the rather poor results obtained there, and is hardly a fair test of the efficiency of an outfit of this kind. The contractors were inexperienced in handling this kind of an outfit, and there were numerous breakdowns of parts of the engine and the delay in getting the broken parts duplicated. During the progress of the work it became apparent that certain parts of the engine were entirely too frail to stand the strain on them, and they were constantly breaking, causing delays. A remedy for this fault would be to have the weak parts made of steel.

CAVING BANKS.

There is but one point in this district threatened by caving bank. That is in the vicinity of Polks Landing, on levee miles 24 and 25 (266 L.), where the distance from the levee to the river is 315 feet. The caving there has apparently decreased in rate. Should the levee become endangered there the local levee board will undertake the construction of a loop.

HIGH-WATER PROTECTION.

High-water protection was undertaken entirely by the levee board. About all the work that was necessary was to combat wave wash at exposed places, which at no time seriously threatened the safety of the levee.

Respectfully submitted.

M. Gardner,
Assistant Engineer.

Capt. E. W. Van C. Lucas,
Corps of Engineers.

Appendix 2 J.

REPORT OF MR. M. GARDNER, UNITED STATES ASSISTANT ENGINEER, ON LEVEES, WHITE RIVER LEVEE DISTRICT, FOR SEASON 1903-4.

Memphis, Tenn., *May 1, 1904.*

Captain: I have the honor to submit the following report of operations in the White River district for the year ending April 30, 1904:

This district begins at Helena, Ark. (306 R.), and extends to near the mouth of White River (385 R.). It is 74 miles long, of which the United States controls 67; the remaining 7 miles is a private levee known as the Laconia Circle levee, and is maintained by the Laconia levee board.

There is still open in this levee district four breaks caused by the 1897 flood, aggregating 10,000 feet in length. The area to be protected by this levee when completed is about 910 square miles. At the beginning of the year there were three of the 1902-3 contracts still in force, the contractors being unable to complete them on account of the unusual weather conditions and high water. They were as follows:

Location.	Miles below Cairo.	Total.	Amount done.	To be done.
		Cubic yds.	*Cubic yds.*	*Cubic yds.*
1/49-3.0	308 R.	90,137.3	47,331.0	42,806.3
17/49-18/48	324 R.	57,216.9	29,582.0	27,634.9
37/32-38/34	344 R.	56,603.8	30,913.0	25,690.8
Total	....	203,958.0	107,826.0	96,132.0

leaving 96,132 cubic yards to be done and paid for out of the allotment of $90,000 made from the appropriation of 1902-3.

From the allotment of $70,000 made from the appropriation of 1903–4 the following work has been done:

Location.	Miles below Cairo.	Quantity.	Price.	Cost.
		Cubic yards.	*Cents.*	
3/0- 4/7	309 R.	58,293.0	17.70	$10,317.86
17/8–17/49	324 R.	31,709.1	19.85	6,294.26
22/0–22/37	326 R.	40,114.8	35.00	14,040.18
47/0–47/38	365 R.	28,266.9	18.75	5,300.04
48/32–48/53	365 R.	15,231.0	18.75	2,855.81
51/29–56/40	366 R.	125,096.8	18.75	23,455.70
Total	....	298,711.6	....	62,263.85

In addition to the above-mentioned work the following topping was done, some by the cubic yard and some with hired teams by the day.

TOPPING BY THE CUBIC YARD.

Location.	Miles below Cairo.	Quantity.	Cost per cubic yard.	Total.
		Cubic yards.	*Cents.*	
23/12 + 50–24/50	327 R.	8,327.7	30.00	$2,498.31
24/50–27/8	328 R.	9,569.5	30.00	2,870.85
Total	....	17,897.2	....	5,369.16

TOPPING BY THE DAY.

19/49–22/0 22/37–23/12 + 50	325 R.	16,446.5	29.90	$4,917.49
60/0–66/20	384 R.	20,582.6	30.80	6,339.44
Total	....	37,029.1	....	11,256.93

The grade to which all the above-mentioned work was constructed is from 1 to 2½ feet below the Mississippi River Commission grade.

Total cubic yards put in place by the United States since last annual report	449,769.9
Cost without engineering expenses	$96,144.00
Average cost per cubic yard, cents	21.38

The amount of money expended during the year, including office and engineering expenses and contingencies, was $113,399.38, making the final cost 25.21 cents per cubic yard.

The money expended includes $1,432.36 paid Gilchrist Brothers for some work done and expenses of moving camp on a contract which was annulled, and $2,227.51 expended for high-water protection.

The local authorities have enlarged and repaired during the year levee amounting to 142,980 cubic yards, at an average cost of 20.39 cents per cubic yard. The total expenditure by the local authorities was $30,460.77, making a final cost of 21.30 cents per cubic yard.

During the year earth has been added to the levee as follows:

	Cubic yards.
By the United States	449,770
By the levee board	142,980
Total	592,750

No levee has been lost or abandoned during the year.

The following is a summary of the earth in the levee in this district:

	Cubic yards.
Put up by the United States and in place April 30, 1903	6,228,725
Added this year	449,770
	6,678,495
Put up by the levee board and in place April 30, 1903	1,490,240
Added this year	142,980
	1,633,220
Levees in place April 30, 1904:	
Erected by the United States	6,678,495
Erected by the levee board	1,633,220
Total in place to date	8,311,715

SURVEYS AND EXAMINATIONS.

Surveys and examinations were made as follows:

At Helena, Ark., to obtain data for approximate estimates for a new loop and two cross levees, should it become necessary on account of the caving bank, to construct either a new loop around, or two cross levees, one above and one below the threatened point.

At Westover, of the caving bank there to determine the rate of caving.

At Old Town, of the caving bank and the country back of the levee, with the view of locating a new loop there.

At Modoc, of the breaks and caving bank in that vicinity, to determine the practicability of building loops around the breaks.

From Fergusons to Beiths, to determine the rate of caving.

CAVING BANKS.

There are several places in this district where the caving bank is threatening the levee, viz: At Helena, Ark., where during the extreme low water the bank caved considerably. The cause here appears to be a low-water one, that is, it caves only at very low stage of the river. At Westover the river is getting quite near the levee. Here the caving occurs during a rise in the river and immediately following a fall. The same can be said of Old Town, while at the lower end of the new Ferguson loop caving has been going on quite actively since the 1903 high water, and it seems probable that a new loop will have to be constructed there this season. At Wood Cottage, 1½ miles farther down the levee, a bad low-water cave occurred. The bank there had been perfectly stable since 1899, but during the extreme low water of the past season it began to cave, but stopped when the river began to rise.

GENERAL REMARKS.

The levee in this district is generally low and of insufficient cross section, the slopes being steep, crown narrow, and more than one-half the district without banquette. In many places the levee is grown up with small trees, underbrush, and weeds, killing the bermuda sod and otherwise injuring the levee.

It is to be regretted that more money is not allotted to this district each year, for the needs of the existing levee are more than the allotments can provide for, and besides, at several points the caving bank is going to make it necessary to construct expensive loops in the next year or two; and again, the four breaks caused by the 1897 flood are still open, with no immediate prospects of being closed. The closing of these will take at least three years' allotments.

HIGH-WATER MAINTENANCE.

About the last of March it became apparent that the river would reach a flood stage throughout the district. In compliance with your instructions I left Memphis April 2 on the U. S. S. *Graham* with a small supply of sacks, shovels, and wheelbarrows on board to effect an organization for the maintenance of the levee. The district was divided into divisions of from 20 to 25 miles and an inspector put in charge of each division, with two or more assistants whose duty it was to patrol the levee and watch for any signs of weakness, have the same repaired, and do anything else that might develop for the protection of the levee. The flood culminated April 15, with a stage of 47.7 feet on the Helena gauge.

The behavior of the levee during the flood was very gratifying; there was absolutely no seeping on the slope of the levee, and not as much as usual beyond the toe. At some places where the road is near the toe of the levee the ground got pretty soft. Those places were fenced in to stop traffic, and gave no trouble. During the severe wind storm of April 8 and 9 there was some wave wash at Helena and the Westover front. At the latter place the levee board constructed a plank breakwater which prevented further wave wash.

The following is a statement of money expended for high-water protection by the United States and by local levee boards:

Cost to the United States.

Services of U. S. steamer *Graham*	$941.21
Labor and inspection	401.50
15,000 sacks	846.15
150 pounds twine	18.00
Freight bills	20.65
Total	2,227.51

(The sacks and twine were not used, it not being necessary to do any work of that kind).

Cost to the local levee boards: For high-water protection, $1,315.65, the most of which was for a plank breakwater on the Westover front.

Respectfully submitted.

M. Gardner,
Assistant Engineer.

Capt. E. W. Van C. Lucas,
Corps of Engineers.

Appendix 2 K.

REPORT OF ASSISTANT ENGINEER A. J. NOLTY ON HIGH-WATER OPERATIONS IN FIRST DISTRICT DURING THE HIGH WATER OF APRIL, 1904.

Memphis, Tenn., *May 1, 1904.*

Captain: I have the honor to submit my report of operations of the high-water levee protection party under my charge during the flood of April, 1904.

Pursuant to your verbal instructions, I detached three good, reliable men from the fleet force to proceed to Luxora on April 1, and upon arrival there each one was to procure a saddle horse and to then take stations as follows, viz: One the section of levee from Barfield to Rosa, one from Rosa to Sans Souci, and one from the latter place to milepost 98, the section of levee from Barfield to milepost 98 being that assigned to me. These men were to thoroughly familiarize themselves with the conditions of their several sections, locating weak and exposed places, and also to pick out places most accessible from the river so that, in case of necessity, material could be quickly carried by skiff from the steamer to the levee. In further pursuance of your orders, I proceeded on the steamer *Chisca* on April 3, to take personal charge of the 46 miles of levee allotted to me, making Luxora my headquarters, as the facilities for communicating with your office, and with the various stations were most convenient here. I also took along Overseer C. W. Fink to take personal charge of any work that it would be necessary to do. The boat also carried a supply of sacks, shovels, wheelbarrows, coal, etc.

On my initial trip up I stopped at the various stations to examine those parts of the levee reported by the inspectors as needing attention. Sacks, shovels, and barrows were left at or near places where there was a probability that work would be required.

The first point that required attention was the angle below milepost 97. Here we had some hard work during the flood of 1903, and during the past fall the levee board put up some new work. As soon as the water gets against the levee a very strong current runs along the upper side of the angle. The part liable to erosion was revetted with sacks, and after this was done no further work was required here.

Luxora is the place where a very costly fight was made during the flood of 1903. There was much low levee between this place and the town of Osceola, and also for 1½ miles above the former place. The levee board did some enlargement work along here during December, 1903, and January, 1904, raising the grade about 4 feet. The enlargement was mainly on the river side, and the slope was very steep, not much flatter than a natural one. Instead of plowing up the old sodded slope before putting fresh material upon it they simply plowed shallow furrows longitudinally and about 3½ feet apart. While this method of effecting a bond between the old and the new dirt can not be recommended, it proved of considerable advantage to us in our subsequent fight here.

Upon my arrival at Luxora there had already taken place considerable chipping off of the new dirt, caused mainly by wash from steamboat waves.

It was at once seen that the main high-water fight would be along this levee, situated as it was close to the river with no protection of any kind to break the waves in front and with steep slopes of green dirt. A small party was at once employed to repair such places where the levee had been badly chipped, and the overseer was charged to watch this front closely. A considerable amount of material was stored convenient for immediate use.

On the afternoon of the 7th a heavy wind and rain storm came up, and this finally settled into a very heavy southwest windstorm, lasting continuously until daylight of the 9th, sometimes assuming the intensity of a hurricane.

At daylight of the 8th it was seen that for 2 miles, from Luxora down, the levee was already badly damaged and caving continuously. The storm increased in intensity as the sun rose, and parties were sent out to notify the neighboring planters to send hands to the levee as quickly as possible. Not meeting with much encouragement from these people, the railroad and mills were appealed to, and in a short time 268 men were at work sacking the slope. These men came from the Frisco and the St. Louis, Memphis and Southeastern railways, from Wolverton's sawmill, Piqua Handle Factory, and from the Osceola Oil Mill, not more than 20 having been sent by the planters. All the men worked hard and faithfully, and by night things were in such good shape that all but 20 were laid off, the small force retained being kept on duty all night, further securing some of the most dangerous breaks.

The storm subsided on the morning of the 9th, and the river having come to a stand, all work was stopped here. It is estimated that fully one-half of the recent enlargement work has been washed away along a stretch of over 2 miles. Fortunately the old slope, not having been denuded of its sod, offered considerable resistance to wave wash after the new dirt was washed off, and this fact largely contributed to the successful outcome of the fight.

Had we experienced no heavy storms during the prevalence of the flood, the expense of high-water protection on the division under my charge would have been small.

Just back of Rosa Landing, where the Mill Bayou levee joins the long tangent running parallel to the river, a short spur was built several years ago to deflect the strong current away from the angle. The elevation of this spur was considerably lowered during the flood of 1903 by being overtopped, and much sacking had to be done here during that flood to prevent erosion of the salient angle of the levee. Sacks and tools were left here for use in case of need, but as the spur was overtopped only at one very low place, labor costing $1.60 was all that was required here.

Toward the latter end of the flood period, the levee began to seep freely, and a close watch to detect sloughing was kept. At only one place, however, was seepage serious enough to require corrective treatment. This was just below Lanier's, at a place known locally as the "Blue Hole." This hole, or depression, is a washout from a crevasse that occurred in 1897, and the levee across it is quite high. Five boils, all discharging mud or sand, and one situated a considerable distance from the base, were walled in with sack dams, and the extensive sloughing near the foot of the slope was treated with a double layer of filled sacks laid upon a thick mat of hay. Had the river remained at flood height but a week longer, conditions would have become very serious here, as well as at other places, for the increase in seepage was plainly perceptible from day to day.

More than ordinary seepage was noted at milepost 73, above Luxora, and at milepost 98, but owing to the short duration of the flood height no work was required.

CONDITION OF THE LEVEE.

Many of the mileposts are missing. How they have disappeared I am unable to say, unless we adopt the suggestion of one of the citizens that these posts, being of cedar, make good whittling material. From milepost 56 (Barfield) to milepost 69 (Rosa) the levee is in good condition, and well protected against wave wash. There were a few seeps at milepost 67 and between 67 and 68, but of no consequence. From Bear Bayou to milepost 69 the levee is somewhat low. From 70 to 71 seepage is light as far as Reeves tram road. Three hundred feet below this tram there is some bad seepage; from thence to 73, light. From 73 to the Frisco crossing at Luxora there was considerable seepage, and complete exposure of the levee to wave wash. From milepost 74 to 78 the levee is exposed to the river, having no protection against wave wash. Along this stretch is where the main fight was made during the last flood. There was very little seepage here, except at Lynchs Bayou, milepost 76.

In putting up the enlargement last winter contractors were allowed by the levee board to take dirt from the land side. Where the levee runs through the town of Luxora, just south of the main street, there is a long deep borrow pit not far from the toe of the levee, and this seeped considerably. Had the river remained at flood height for any length of time a serious blowout might have occurred here.

From 78 to 79 there was very little wave wash, and no seepage with the exception of one place 400 feet north of 79, where there was bad seepage. From 79 to 83 only light seepage and very little wash. From milepost 83 to 86 the levee was in fine shape; between 86 and 87 it is badly damaged for three-fourths of a mile by logging across it.

Between 87 and 88 the Blue Hole is located, and here was the worst seepage and sloughing on the entire levee. From 88 to 97 the levee is in good shape. There were neither mileposts nor gauges along here. Between 97 and 98 is located the angle in the levee which had to be protected against erosion. The balance of the mile was fairly good, except for some seepage at 98 and the absence of sod on the slope.

RECOMMENDATIONS.

It is recommended that a good banquette be added to the levee at the Blue Hole, at Lynchs Bayou, and from milepost 72 to the Frisco crossing at Luxora. Also that a permanent spur be built at the junction of Mill Bayou with the main river levee, and at the angle between mileposts 97 and 98. Also that some provision be made against damage by wave wash where the levee is open to the river. This could probably be best attained by inducing a growth of willows or cottonwoods in the borrow pits. These depressions nearly always hold enough moisture to foster these growths, and as they are rarely cultivated it is believed that the planter would not offer any opposition to such planting. Such a barrier would largely reduce the cost of maintenance of levees during flood periods.

High-water stakes were set at every existing milepost, and where these were gone a high stake was set opposite the high water and on the land side slope.

The following tables show the cost of the flood protection and the amounts spent at the various places where work was required:

Statement of expenses for high-water levee protection, flood of 1904, from Barfield, Ark., to milepost 98, Arkansas, 46 miles.

Subsistence	$133.00
Labor, steamer *Chisca*	401.92
Coal, 2,800 bushels	422.40
Oils and engineers' supplies	147.78
Sacks from Osceola Oil Company, 4,000	205.20
Sacks from fleet, 16,200	858.60
Rubber boots, 24 pairs	120.00
Lanterns, 19	14.25
Express charges on money ($1,500)	1.50
Freight on sacks, etc., steamer *Robert E. Lee*	36.50
Transportation, labor Osceola to Luxora	10.00
Transportation 3 foremen, Memphis to Luxora	7.50
Horse hire for foremen, 44 days	66.00
Paid laborers and foremen for labor	684.32
Total	3,108.97

Labor account high-water levee protection, flood of 1904.

Mill Bayou	$1.60
Luxora	408.21
Laniers	47.00
Milepost 97 to 98	22.50
Steamer *Chisca*	401.92
Overseers and inspectors	212.63
Total	1,093.86

Unpaid labor included in above, $7.65.

Sacks used.

Mill Bayou	25
Luxora	17,475
Laniers	2,000
Milepost 97-98	700
Total	20,200

The organization of the force as outlined by you was admirable in every respect. The good results obtained are due to the plan of organization and to the personnel. The entire force, both the land and the steamer, performed their duties with alacrity and strict attention to the business in hand.

Respectfully submitted.

Aug. J. Nolty,
Assistant Engineer.

Capt. E. W. Van C. Lucas,
Corps of Engineers.

Appendix 2 L.

REPORT OF MR. CHAS. LE VASSEUR, UNITED STATES ASSISTANT ENGINEER, ON CAVING BANKS, FIRST AND SECOND DISTRICTS, DURING THE SEASON 1903-4.

Memphis, Tenn., *May 1, 1904.*

Captain: I have the honor to submit the following report on caving banks in the Upper St. Francis, Reelfoot, and Lower St. Francis levee districts during fiscal year 1903-4.

UPPER ST. FRANCIS DISTRICT.

In this district the caving of the river bank during this fiscal year has not affected the levees.

In the upper part of the district the caving took place above and below the town of Birds Point, where the levee is situated at a safe distance from the river. Above the town the erosive action has been most active on a length of about 4,000 feet, and attained a maximum width of caving of 500 feet, forming a long pocket which endangered the Iron Mountain Railroad track entering Birds Point. Below town the caving began just at the angle of the levee station 1/18+93 and extended eastward to the extreme end of Birds Point, a length of 5,500 feet, with a maximum width of caving of 350 feet. The levee at station 1/18+93 is now 300 feet from the bank line.

The caving above and below the town of Birds Point is due to the formation of sand bar and to the extension southward of Cairo Point bar.

A small cave occurred in the vicinity of Norfolk Landing (7 R.). This caving is taking place at midstage only, extending about 800 feet south, but its action is very slight (maximum 60 feet) and offers no immediate danger to the existing levee. In Lucas Bend (15-20 R.) caving was very active and attained a maximum of 650 feet. The river bank is now situated in the head of Bradshaw Lake. This caving obliged the location of the levee proposed to be constructed during next fiscal year to be kept far enough from the bank to secure the embankment a fifteen years' life.

REELFOOT DISTRICT.

The caving observed during this fiscal year in this district is very slight, and extends from French Bayou (40 L.) to the head of French Point, a length of about 2 miles, with a maximum width of 75 feet, and along the front of Island No. 9, a length of 1½ miles (54 L.), where the action of the river caused a regular wearing of the bank.

LOWER ST. FRANCIS DISTRICT.

In the Lower St. Francis district the caving of the river bank during this fiscal year has been very rapid at several localities, destroying or forcing the abandonment of some of the existing levees.

At Point Pleasant, Mo. (79 R.), the head of the upper caving is 2½ miles above the town on longitude 89° 33′ and latitude 36° 30′, and extends along the southeast bank of Island No. 11, where a slough was separating this island from Toney's Towhead.

The entire Toney's Towhead is practically gone, its extreme south point only remaining and the original bank of Island No. 11 has also been taken away for an average width of 800 feet. The river from the foot of Island No. 11 has encroached on the mainland for a length of about 6,000 feet and an average width of 1,000 feet.

Fifteen hundred feet of levee have caved into the river from Stations 0/0 to 0/15. The embankment was 5.6 feet high and the yardage lost about 8,000 cubic yards.

The river bank and the ground generally above Point Pleasant is very high, being the south slope of Lewis Prairie Ridge (the continuation of Big Prairie high ridge). Only during an extreme high flood could the Mississippi water inundate the country back of Point Pleasant through the breach caused by this caving. The lower caving is situated at and immediately below Point Pleasant. In 1899 at this place the river bank began to cave in, and during this fiscal year the caving extended in width and length and created a deep pocket just abreast of station 1/17+83 of the levee.

The rate of caving above Point Pleasant has been as follows: Between 1889 and 1897, eight years, 850 feet; between 1897 and January, 1904, seven years, 1,750 feet; between January and April 30, 1904, three months, 70 feet.

The rate of caving below Point Pleasant has been as follows: Between 1889 and 1897, eight years, 500 feet; between 1897 and 1899, two years, 250 feet; between 1899 and January, 1904, five years, 500 feet; between January and April 30, 1904, three months, 20 feet.

A new levee loop is projected to be constructed during next season's work, from a point on the existing levee, station 1/39+82 to the high land of Lewis Prairie, to close the breach made by this caving. The length of this new loop will be 9,550 feet, and the estimated yardage 86,000 cubic yards.

From Gayoso, Mo. (105 R.), to the head of Islands 16 and 17 (114 R.) the bank during the year has been caving. The active caving took place just below the town of Caruthersville, Mo. (110 R.), 1,500 feet below the end of the bank revetment, where part of the loop levee built in 1902-3 was rendered useless and a new loop had to be erected during this fiscal year.

The rate of caving at Caruthersville, Mo., has been as follows: Between April, 1902, and June 15, 1903, 520 feet; between June 15 and August 23, 1903, 360 feet; between August 23 and September 30, 1903, 250 feet; between September 30, 1903, and April 30, 1904, 150 feet.

In 1902-3 a new loop was constructed near Arkansas and Missouri State line, from station 46/15 to station 47/31 (127 R.) in rear of the front levee, as the bank at this locality was caving very rapidly. Since last year's report the caving has not materially increased, a change in the river just opposite this point having deflected the current from the Arkansas bank.

In the vicinity of River Styx (140 R.) since 1891 the bank has been continually caving, and the bank had approached very close to the levee between stations 54/19 and 55/10. During this fiscal year the increase of caving took place opposite station 54/40 and left only a distance of 150 feet between the center of the embankment and the edge of the river bank.

The rate of caving at this place has been as follows: Between 1891 and 1897, six years, 300 feet; between 1897 and October, 1903, 880 feet; between October, 1903, and April 10, 1904, 110 feet.

On account of the caving bank a new levee loop in rear of the existing levee will be constructed during next season, and the levee to be abandoned is calculated to contain 108,000 cubic yards.

From Carson Landing (190 R.) to Pecan Point (196 R.) the bank since 1883 has been subject to erosion and caving. The caving along this bend is irregular and forms a succession of pockets where the action of the current is more or less intense. The caving along the total length of this bend (Island 35 bend) has a maximum general average of 85 feet per year during a twenty-year period, and the existing levee, notwithstanding its close proximity to the river edge, is not for the present in danger by this rate of caving. In my report submitted December 6, 1903, I gave in detail the rate of caving of the different points along this Island 35 bend.

From mile post 140 (218 R.) to station 143/15 (221 R.) the levee is also very close to the river bank, the least distance, 700 feet, being at mile post 143.

The caving since 1899 has been 850 feet, or 170 feet per year. This caving does not, in my mind, threaten the existing levee on Rodman Point, as this caving is due to the bar formation at the foot of Island No. 40, on the Tennessee side, which is now extending southward and will there force the caving lower downstream where the levee line leaves the bank of the river.

The caving along Walnut Bend (280-284 R.) has progressed since last year's report. A survey is now being made to ascertain the extent of this caving. The results of this survey are not available for this report.

Respectfully submitted.

Chas. Le Vasseur,
Assistant Engineer.

Capt. E. W. Van C. Lucas,
Corps of Engineers.

APPENDIX 2 M.

REPORT OF MR. A. MILLER TODD, ASSISTANT ENGINEER, ON OPERATIONS IN LOWER YAZOO LEVEE DISTRICT DURING THE SEASON OF 1903-4.

MEMPHIS, TENN., *May 1, 1904.*

CAPTAIN: I have the honor to submit the following report of operations in the Lower Yazoo levee district for the season of 1903-4:

Extent of district and yardage.—The district covers the east bank of the river from the Coahoma-Bolivar County line (367 L.) to the mouth of the Yazoo River (599 L.) (mouth of Yazoo diversion canal), a river frontage of 232 miles. The line of levee is continuous to a point in Warren County on Eagle Lake about 7 miles back of Brunswick Landing (580 L.).

There was built during the year, under the direction of the United States engineers in charge of the improvement of the mouth of the Yazoo River and Vicksburg Harbor, about 1 mile of levee from just across the mouth of the Yazoo diversion canal opposite Kleinston (599 L.), extending across West Pass up toward Kings Point. This levee was not constructed for the purpose of preventing overflow, but to shut off the inflow and outflow through west pass of Lake Centennial, cutting off the eddy up past Vicksburg. It is constructed to a grade of 4 feet above the high-water of 1897, 8-foot crown, 3 to 1 slopes on both sides; average height, 22 feet; contents, 293,341 cubic yards; put up at a cost of $96,655.46.

A river frontage of 19 miles is yet unleveed, and a large portion of Issaquena, Sharkey, Warren, and Yazoo counties is overflowed from backwater, beginning at a stage of 45 feet on the Vicksburg gauge. At a stage of 49.4 there is estimated to be an area of 600 square miles overflowed from backwater.

The following table shows the new loops completed during the year, the changes in length, and the yardage, and the yardage contained in the levees abandoned:

Location of new loops.	Miles below Cairo.	Stations.			Length.		Cubic yards thrown out.
		Beginning.	End new levee.	End old levee.	New levee.	Old levee.	
					Feet.	*Feet.*	
Waxhaw	380 L.	1038+13	1225+83	1328.30	18,770	29,017	932,700
Lagrange	480 L.	140	210+46	197+73	7,046	5,773	52,161
Baleshed No. 1	535 L.	3166+50	3174+50	3174+50	800	800	19,500
Baleshed No. 2	536 L.	3188	3203	3203	1,500	1,500	40,000
Shipland	545 L.	3491+10	3586+93	3586+12	9,583	9,502	206,000
Cottonwood	555 L.	4265	4276+72	4278+61	1,172	1,361	32,000
Albemarle	568 L.	4854+59	4879+36	4870	2,477	1,541	10,052
Total							1,292,413

The net change of length amounts to a shortening of 8,146 feet, equal to 1.54 miles. The total length of the continuous levee line is now 186.8 miles.

	Cubic yards.
Added during the year by the United States	1,905,842
Added during the year by the levee board	1,738,266
Total added during the year	3,644,108
Deduct for levees abandoned	1,292,413
Net yardage added	2,351,695
Contents of levee line as estimated May 1, 1903	33,263,691
Contents of levee line May 1, 1904	35,615,386

CONSTRUCTION.

On May 1, 1903, work was under construction of two projects, for description of which see report of Mississippi River Commission for 1903, pages 245-246.

The following table shows all uncompleted work under contract at the time of the last annual report:

Stations.	Miles below Cairo.	Kind of work.	In place May 1, 1903.	To be placed May 1, 1903.	Contractor.
			Cubic yards.	*Cubic yards.*	
1038-1080	380 L.	New levee		160,000	M. J. Roach & Co.
1080-1116	380 L.	do		175,000	Do.
1116-1150	380 L.	do	972	144,028	Do.
1150-1183	380 L.	do	66,175	93,825	Do.
1183-1226	380 L.	do		160,000	Do.
1840-2070	402 L.	Enlargement		160,000	Lowrance Bros.
2130-2230	403 L.	do		65,000	Do.
3100-3125	434 L.	New levee	85,431	57,569	M. J. Roach & Co.
3125-3156	434 L.	do	100,870	44,130	Do.
3189-3229	434 L.	do	125,582	24,418	Do.
3229-3245	434 L.	do	114,152	27,848	Do.
100- 200	480 L.	Enlargement		60,000	Walker Stansell.
600- 790	496 L.	do	3,509	96,491	Do.
1346-1730	500 L.	Banquette enlargement		100,000	Do.
1730-2108	505 L.	Banquette	13,777	71,223	Do.
2572-2880	531 L.	do	35,005	24,995	Lowrance Bros.
3800-3942	552 L.	Enlargement	24,565	80,435	L. C. Dulaney.
4670-4725	567 L.	New levee	136,868	11,005	Israel R. Bobbitt.
4780-4890	568 L.	Enlargement		60,000	Thos. Worthington.
4890-5000	569 L.	do	21,520	53,480	Donovan & Daley.
5000-5170	570 L.	do		75,000	Morgan & McCarten.
Total			728,426	1,744,447	

All construction work had been suspended on account of the flood stage of the river, and at the beginning of the period covered by this report forces were at work on but three of the contracts, viz: Stations 1116-1150 (380 L.) and stations 1150-1183 (380 L.), of the new Waxhaw levee, and stations 1730-2108 (505 L.), banquette work.

On June 10 proposals were received for constructing a levee around Lagrange crevasse (480 L.). The work was divided into two sections, the upper one, stations 140-177, containing 133,000 cubic yards, and the lower one, stations 177-210, containing 137,000 cubic yards. Both sections were placed under contract with Walker Stansell at 15.74 cents per cubic yard, he being the lowest bidder. Work was commenced on both sections on June 18, 1903. The seep water and the June rise delayed very active construction until July 1.

On September 5 proposals were received for building a levee around the Albemarle crevasse. One contract was let, from stations 4854 to 4879 (568 L.), to Lowrance Bros., at 21.5 cents per cubic yard. Force was moved on this contract at once and work was under way by September 15, 1903.

All work under contract was very well covered by November 1, with the exception of the following: Section 2, Waxhaw Loop (stations 1080-1116, 380 L.); the four uncompleted sections of Jenkins loop (434 L.); the enlargement contract, stations 100-200 (480 L.); the banquette contract, stations 1346-1730 (500 L.), and the enlargement contracts, stations 4780-4890 (568 L.), and 5000-5170 (570 L.).

The weather conditions were the very best, scarcely a day being lost on account of rain from September to March. A table showing the rainfall at Greenville from May 1, 1903, to May 1, 1904, is appended to this report, which also shows the mean rainfall from 1886 to 1904. The total rainfall for the year was 14.06 inches less than the mean for the eighteen years beginning with 1886.

The labor conditions, however, were very acute in many localities, and in most every instance the contractors were short of labor practically all the time. During the latter half of October the contractors were all notified that they must put sufficient forces to work on their respective contracts to complete by February 1, 1904, the expiration of contract time for all the new contracts. Plenty of teams were moved on the work in most cases, but on account of the acute labor conditions the work fell behind about a mouth.

Thomas Worthington, contractor for the enlargement work, stations 4780-4890 (568 L.), refused to undertake the work, claiming that on account of a crevasse washing away some ten stations the conditions were so materially changed as to justify the annulment of the contract. After finding that the contractor was not going to take any steps to move a force on the work, a contract was entered into with G. A. Lowrance to do the work at 23 cents per cubic yard. The price bid by Worthington was 19.4 cents per cubic yard.

On account of the impossibility of obtaining new contractors with available outfits to move on the Lagrange and Albemarle crevasse loops and on other contracts, the completion of which was considered important before the high-water season of 1904, the contractors on all the contracts now remaining uncompleted were given extension of time in order that they might undertake and push to completion the more important work. All the contracts intended to be completed before the high water were finished by March 1. Work progressed satisfactorily on the remaining contracts up to the time of the overtopping of the banks by the river early in April. By April 15 work was suspended on all the uncompleted contracts except the Jenkins loop (434 L.).

The following is a list of the uncompleted contracts remaining on April 30, 1904.

Stations.	Miles below Cairo.	Kind of work.	In place May 1, 1904.	To be placed May 1, 1904.	Contractor.
			Cubic yards.	*Cubic yards.*	
1840-2070	402 L.	Enlargement	67,892	92,108	Lowrance Bros.
2130-2230	403 L.	.....do	85,878	33,622	Do.
3189-3229	434 L.	New levee	139,637	10,363	M. J. Roach & Co.
3229-3245	434 L.	.....do	127,418	14,582	Do.
100-200	480 L.	Enlargement	19,930	10,070	Walker Stansell.
1846-1730	500 L.	Banquette	64,695	35,300	Do.
Total			455,450	196,045	

Methods of construction.—Methods of levee building have remained practically the same as heretofore. The only change of note is the use of traction engines of from 12 to 20 horsepower to pull the elevating graders used for loading dump wagons, instead of the large number of teams used heretofore. The traction engines work very well for this purpose where the material is a firm, hard buckshot, but where a soft material is encountered the engines are unable to pull the grader on account of the driving wheels slipping.

The use of the engines does not seem to materially increase the team average, allowing that the engines themselves are an equivalent to eight teams each, which is a fair estimate; the only advantage gained in their use is a saving in the number of laborers necessary to operate an outfit. They are very troublesome and expensive to keep up, much time being lost on account of breakdowns. In order to successfully operate a grader outfit using traction engines, it must be run on a large scale, and an extra engine kept at all times to take the place of the engines that break down. These engines demand the services of the very highest class of steam engineers for their operation. I do not think that so far they have been a success, as a rule, in levee building.

New specifications.—The advisory board of assistant engineers of the first, second, and third districts, Mississippi River improvement, by your direction, compared and considered the specifications for levee building in use in the three districts, and by adopting the best clauses in all the sets of specifications considered, rejecting useless or obsolete provisions, and making such changes as late experience and practice indicated as best, a set of specifications was recommended for adoption as applicable to these districts. The specifications were adopted practically as recommended, and all contracts for the expenditure of 1904-5 allotments were let under these specifications.

Project for expenditure of 1904-5 allotment.—The allotment to the Lower Yazoo levee district for the year 1904-5 was $150,000, from which $50,000 was afterwards deducted to be applied to revetment construction for the protection of levee at Longwood (501 L.). Below is a statement of the project adopted for the expenditure of the $100,000 balance:

Stations.	Miles below Cairo.	Kind of work.	Net grade proposed.	Estimated yardage.
32- 100	478 L.	Enlargement	2 feet above 1903 high water	32,000
200- 550	483 L.	Topping	.....do	60,000
550- 600	483 L.	Enlargement	.....do	20,000
940-1000	494 L.	.....do	.....do	70,000
1000-1100	495 L.	.....do	.....do	110,000
1100-1200	496 L.	.....do	.....do	100,000
1200-1370	497 L.	Topping	.....do	20,000
Total				412,000

Enlargement, 8-foot crown, 3 to 1 slope both sides. Topping, 4-foot crown, 3 to 1 slope on land side, 2 to 1 slope on river side.

Total earthwork, 412,000 cubic yards, estimated to cost	$75,000
Weed cutting, etc	6,000
Engineering, surveys, etc	19,000
Total	100,000

Proposals were received for the earthwork on April 13, 1904, and the seven sections were awarded to M. J. Roach & Co., at 18.9 cents per cubic yard, this being the lowest bid received. Contractors are beginning to move on the work already, and as soon as the stage of the river will permit this work will all be put under construction.

A table accompanies this report, showing cost and all construction details of work done during the year. The average cost of all work let in the district, not including the contracts let on April 13, 1904, was 17.2 cents per cubic yard.

Levee board construction.—The Mississippi levee board had at the beginning of the present season 600,000 cubic yards of uncompleted work under contract. Practically all of this work has been completed during the season. Since May 1, 1903, they have put under contract and undertaken by day force 4,236,987 cubic yards, of which 3,726,636 cubic yards was for new loops to cover caving banks. A statement accompanies this report, showing work done by the Mississippi levee board during the year.

REPAIRS AND MAINTENANCE.

Considerable damage has been done to the exposed reaches along the levee line by severe windstorms while the river was against the levee during the flood of 1903, and weak points developed at several places, which it was thought best to cut out and strengthen. The line was overtopped below Greenville by the flood level for long stretches, and here the dirt had been moved over from the land side of the crown to the river side in order to afford a little additional height.

A project for repairing all such reaches was formulated in June, 1903, covering the expenditure of $40,000 then available for this purpose. Later it was found necessary to include the Albemarle crevasse loop, which was estimated to cost $20,000, thus reducing the amount available for repairs to $20,000, and the original project was considerably modified, leaving off most of the emergency topping. The repair work was done by hired teams, the contractor furnishing complete outfits, including all tools and labor. Two outfits were employed, one above Greenville, G. R. Lacy, contractor, furnishing 16 teams at $6.50 per day, and the other below Greenville, L. C. Dulaney, contractor, furnishing 20 teams at $6 per day. This plan was found very satisfactory, as it was not necessary to set any definite localities at which to work.

Each contractor commenced at the upper end of his respective reach, each outfit being in charge of a capable inspector, employed by the Government, and only the most important and urgent work was undertaken. The following statement shows in detail all repairs undertaken, together with the cost of same, and locality of work:

Stations.	Miles below Cairo.	Nature of work.	Cubic yards handled.	Cost.	Cost per cubic yard.
					Cents.
215–400	368 L.	Restoring section of levee damaged by wave wash	15,802	$3,507.25	22.2
1610–1647	400 L.	Emergency topping	3,108	1,140.75	36.7
1698–1700	402 L.	Excavating dangerous sand boil, taking out about one-half section of levee, digging muck ditch, and restoring removed material	3,371	711.73	21.1
2687–2640	418 L.	Removing brush and sacks, excavating and cutting muck ditch, and refilling slough	6,946	1,466.50	21.1
2650–2670	418 L.	Restoring section of levee damaged by wave wash	2,623	561.00	21.0
3330–3410	437 L.	Restoring section of levee damaged by wave wash (very long haul)	8,282	2,202.82	26.5
		Total above Greenville	40,132	9,590.05	23.8

Stations.	Miles below Cairo.	Nature of work.	Cubic yards handled.	Cost.	Cost per cubic yard.
					Cents.
2928-3136	533 L.	Topping to 1 foot above high water, 1903, restoring land side crown of levee, and repairs to road crossings.	12,000	$4,773.00	39.8
3200-3269	537 L.				
3430-3500	543 L.				
4265-4277	556 L.	New emergency levee	24,930	5,749.12	23.1
4215-4265	556 L.	Topping to 1 foot above 1903 high water, restoring land side crown of levee, and repairs to road crossings.	1,825	1,596.00	42.1
4278-4332	556 L.				
		Total below Greenville	40,675	12,118.12	29.7
		Grand total	80,807	21,708.23	26.8

In addition to the above repairs an amount of $622.50 was paid for repairing sloughs on accepted banquette work, bringing the total for the district to $22,330.73.

WEED CUTTING.

Proposals for weed cutting along the line of levee were received July 27, 1903. Contracts were let to the lowest and best bidders, as follows:

Stations.	Contractor.	Number stations in reach.	Price per station.	Cost.
ABOVE GREENVILLE.				
			Cents.	
0-500	E. M. Allen	500	50.0	$250.00
500-1038	.....do	538	35.0	188.30
1500-3100	.....do	1,600	45.0	720.00
3283-3410	B. F. Lacey	177	43.0	76.11
3562-4200	.....do	638	43.0	274.34
Total		3,453	43.7	1,508.75
BELOW GREENVILLE.				
200-1000	B. F. Lacey	800	45.0	360.00
1300-2100	Thos. Worthington	800	40.0	320.00
2100-5888	Jno. M. Chilton	3,314	22.0	729.08
Total		4,914	28.7	1,409.08
Grand total		8,367	34.9	2,917.83

In addition to the above contracts, weeds were cut by day labor on 295 stations between stations 500 and 600 and between stations 1730 and 2108, below Greenville; cost $65.08, making a total cost for weed cutting in the district of $2,982.91.

For about two-thirds of the levee line July and August are about the proper months in which to cut the weeds. There are many reaches, however, where the sod has not formed a good mat, and where the levees are fenced in it is imperative to cut the weeds during the latter part of May or early in June. Such reaches have to be cut the second time in August.

Sodding.—No resodding was necessary during the season.

HIGH-WATER MAINTENANCE.

A freshet out of the Ohio, culminating with a rise in the upper Mississippi, caused the river to go above the danger line at Cairo and attain a maximum stage of 49.1 on April 5, 1.5 feet below the maximum reading of 1903. Ten days afterwards the river at Helena came to a stand, registering 47.7 on the gauge, 3.3 feet below the maximum of last year. The following table gives the differences between this flood and the 1897 and 1903 high waters at intervals along the entire district:

Station.	Miles below Cairo, left bank.	Locality.	Below high water, 1897.	Below high water, 1903.	Date of culmination.	Remarks.
			Feet.	*Feet.*	1904.	
0	369	Coahoma-Bolivar county line.	3.1	4.0		
240	370	Australia	3.1	4.0		
860	378	Gunnison	3.1	4.1		
1200	393	Mouth White River gauge	2.9	4.2	Apr. 18	Opposite station 1200.
1500	398	Rosedale	2.9	4.2		
1810	402	Beulah	2.8	4.1		
2600	417	Bolivar	3.5	4.1		
3030	433	Eutaw Landing	3.6	3.9		
3400	439	Arkansas City gauge	2.9	4.0	Apr. 19	Opposite station 3400.
3500	440	Huntington levee	2.6	2.2		
3600	457	Bolivar-Washington county line.	1.0	3.6		
3675	458	Mound Bayou	2.3	3.7		
3882	461	Carters Neck	2.8	3.9		
4270	478	Greenville gauge	3.2	5.6	Apr. 20	
370	484	Warfield Point	3.3	5.5		
830	495	Deerfield	3.0	5.1		
1500	502	Longwood	2.2	5.0		
2000	513	Leota	2.8	5.0		
2900	533	Mayersville	1.8	4.7		
3400	542	Lake Providence gauge	2.0	4.0	Apr. 21	Opposite station 3400.
4000	555	Fitlers	2.4	4.8		
4800	568	Duvall	2.7	5.2		
5200	573	Brunswick	2.0	4.8		
......	599	Vicksburg gauge	5.5	4.9	Apr. 24	

A comparative profile showing the elevation of the top of the levee and the 1897, 1898, 1903, and 1904 high-water slopes throughout the district accompanies this report.

It will be noted that the river was at no place within less than 5 feet of the top of the levees; hence active high-water operations were not necessary. It was necessary, however, to guard against the ends of the spur dikes at Catfish Point, Huntington short line, and across other necks being washed away by the swift current; to be prepared along all the reaches exposed to wave wash in case of severe wind storms arising, and to patrol the levee daily in order that any weak places might be promptly detected. The Mississippi levee board undertook this maintenance as outlined. Revetting the ends of the spurs was the only work found necessary except at Baleshed (537 L.), where a considerable reach of levee was threatened by caving bank. A protection levee had been built covering the nearest point to the river bank, but a very rapid cave developed some distance below the levee covered by this loop. Opposite station 3202, on the night of April 9, the shore caved back a distance of over 100 feet, breaching the main portion of the levee. The cave extended to the intersectiou of the inner banquette crown with the land side slope. The breach was about 120 feet wide. The water was standing about 4 feet high against the slope, and had the levee caved entirely through it would have caused a crevasse, and great damage would have been done. The permanent loop to cover all the line threatened in this locality had just been put under construction by the levee board, and about 150 teams were on the ground. These were put to work on the morning of April 10, building across the sharp angle just back of the breach. Before night this work made the situation safe, in case of at least another cave of 100 feet. A levee 1,500 feet long was commenced at once, and within twenty-four hours this had been brought up above the water level, and was carried up to a safe height within the next four days, and if the front line had caved in this loop would have effectually held out the water. The levee board expended on the emergency loops at this point $11,287.20, and for all other high-water operations $1,536.74.

General remarks on the high water.—By reference to the table showing the comparative heights, it will be noted that this year's high water was practically parallel to the level of the 1903 water from the upper end of the district to Arkansas City. Between Arkansas City and Greenville there appear to be local influences that produce a varying high-water slope, steep at moderately high stages and much gentler as the river reaches an extreme high stage. This influence must account for the average slighter differences between the 1903 and 1904 water levels all the way to the lower end.

SURVEYS, ETC.

Location surveys were made for the following new loops: La Grange (480 L.), Baleshed (537 L.), Albemarle (568 L.), and Albemarle to Chotard.

Shore-line surveys were made at Waxhaw (380 L.), Choctaw Bend (434 L.), Longwood (501 L.); Baleshed (537 L.), Shiloh (555 L.), and Duvall to Chotard (568 L.). All of the above were accomplished with the regular forces in the field engaged on inspection of levee construction, the only additional cost being the hire of a few laborers. All the surveys were plotted, maps and blueprints made, and copies furnished the Memphis office.

BANK LINES.

The caving all along this district has been very active since the 1903 high water. At the date of the last annual report, on account of the water still being over the bank, none of the usual spring shoreline surveys had been made. As soon as the river receded within its banks the caving in nearly all of the bends was observed to be especially active. Below is set forth, briefly, the results of surveys and observations along the active caving reaches, made at intervals during the year.

Parkers to Dennis Landing (*367-373 L.*).—A shore-line survey run in June, 1903, indicated active caving along this entire reach. In February, 1904, the shore line was run by the Mississippi levee board, and showed the following amount of cave at the most threatened points: Station 135, 300 feet caved off in nine months, with 450 feet remaining to slope of levee, and at station 390, 370 feet caved off in nine months, leaving 550 feet between shore and levee.

This amount of caving indicated that the question of a new levee location to cover this front must be considered without delay. The levee board had a very comprehensive survey made of the locality, and they finally decided to let contracts for the entire loop, beginning at the county line and joining the present levee at station 450. The upper end will not be worked on until it is decided whether or not the Yazoo-Mississippi Delta levee board will build from the county line up, connecting with their levee just below the new Malone loop.

Waxhaw front (*392-394 L.*).—A new levee covering this reach was under contract at the date of the last annual report. The caving was so active that it was thought best to push the loop to completion before the high-water season of this spring. This was done, the new levee being entirely completed on March 1, 1904. The caving still continues very active, and the old levee will probably be breached within the next year.

Choctaw Bend (*430-435 L.*).—Caving along this reach has not been very active. The immediately threatened portion of the levee is covered by a new loop under construction. The angle at station 3308 will probably cave in about five years at the present rate, which will necessitate a new loop from stations 3260 to 3350.

Bachelors Bend (*475-479 L.*).—The caving has almost ceased in this reach, and from present indications the construction of a new levee in this vicinity may be postponed indefinitely.

Below Greenville (*478* L.).—Active caving for the first time in many years was noted opposite stations 80 to 140, the caving occurring at about a bank full stage. Opposite station 96 the bank has caved 130 feet since the last survey, in 1894, and practically all went in during this season. At this point there remains only 320 feet from the bank to the levee, and should this caving continue a new levee will have to be constructed within the next two years.

Longwood front (*499-502 L.*).—This bend has caved steadily at the rate of about 150 feet per annum for the past ten years, and after the river came within its banks it was noted that between stations 1400 and 1450 the caving had set in at a greatly increased rate. Surveys indicated that if the rate of caving continued the levee would be breached in about eighteen months. The present levee along this reach crosses what was once the old river bed, and averages 26 feet in height. Surveys were made covering all possible locations for a new levee, and it was found that it would cost more and take longer to build a levee of the most temporary character than would be necessary to construct about 5,500 feet of revetment, which amount would cover the immediately threatened portions of the levee. It has been decided to undertake the revetment during the coming season. The United States will contribute $150,000, and the balance, if any, will be furnished by the Mississippi levee board.

Bend of Island No. 92 (*527-530 L.*).—Caving has continued steadily at the rate of about 150 feet per annum throughout this entire reach. The distance to the river bank from the nearest point to the levee in November, 1903, was 450 feet. The levee board has made surveys for a new loop to cover this reach, and it is probable that this work will be undertaken by them during the present year.

Shipland Front (545 *L.*).—Since 1900 until the past season very little caving occurred along this reach. When the stage of the river reached very near low water, caving set in very actively along the entire reach. From station 3500 to below station 3550 caving amounted in places to as much as 160 feet per month. The levee board let an emergency contract for the construction of a new levee of about 145 stations, and containing about 360,000 cubic yards. This work was let at 27 cents per cubic yard, to be completed in sixty days. Work was commenced about January 10, 1904, and completed March 1. As soon as the river rose to about a midbank stage the caving ceased, and to date the old levee has not been breached.

Shiloh Front (555 *L.*).—The bank opposite the threatened point, station 4215, caved very rapidly during the high water of 1903. Surveys indicate that about 450 feet caved into the river, leaving only 450 feet between the levee and the river. This is essentially a high-water cave, and since the river retired within its banks last season until the water came up this year, practically no caving had occurred. A survey, as soon as the stage of the river will permit, may indicate that a loop will be necessary here during the present season.

Duvall to Chotard (568–570 *L.*).—Caving continues very active throughout this reach. The Duvall loop was completed during the year, covering levee which had breached for about 1,500 feet at the upper end. The rate of caving averages about 200 feet per annum, and from stations 4900a to 4950 the caving during the current period has been especially active. The shore line survey of April, 1904, showed that opposite station 4903 the caving amounted to 260 feet in eight months, leaving only 480 feet between the river bank and the levee. A new levee to cover the threatened reach will, for some 2,000 feet, follow the west bank of an arm of Steels Bayou, and for about 3,000 feet will pass through a low, timber flat, which will make the new levee difficult to build in one season without exceptionally good weather conditions. It is understood that the Mississippi levee board will build this loop, providing they have enough funds to cover the cost. If it is not undertaken by them, it should be provided for out of the 1905–6 allotment for this district.

General remarks on caving banks.—It has been customary to make at intervals shore-line surveys of all reaches where the levee is threatened. This survey only included the location of the bank line. I am of the opinion that a mere knowledge of the progress of the caving is not sufficient data on which to base recommendations for new levees. The surveys should be made regularly at intervals of six months, in May and June, or as soon as possible after the high-water period will permit, and also in October or November, and should include, besides the regular shore-line surveys, the location of ranges about 1,500 feet apart, on which should be based a hydrographic survey from bank to bank. By a comprehensive study of the subaqueous changes I am confident that changes in the bank line may be more confidently predicted, which may influence the new locations, or might probably lead to the saving in levees built, which levees might possibly prove unnecessary on account of cessation of caving.

I estimate that in this district about 25 miles should be surveyed at a cost of approximately $60 per mile, amounting to $1,500 for one survey, or $3,000 for two, during the season.

If it should not be deemed wise to make two surveys during the year, I would recommend that at least one be made, as outlined, during October and November.

HIGH-WATER OBSERVATIONS.

Spikes were set marking the 1904 flood level on all local gauge trees. The elevations were taken by observing the distance below the zero of the gauges which mark the elevation of the 1897 high water. The elevations have been plotted on a profile submitted herewith, showing also for comparison the high-water slopes of 1897, 1898, and 1903. Also the elevation of the top of the levee as it exists at the close of the period covered by this report.

The extent of the backwater around the lower end of the levee system was observed, and the result is plotted on a map submitted herewith, showing also the backwater overflow of 1898 for comparison.

BACKWATER OVERFLOW AT LOWER END OF DISTRICT.

By reference to the overflow map it will be seen that the extent of the backwater was very little less than it was in 1898, when the gauge registered 49.4 at Vicksburg. The maximum gauge reading this year at Vicksburg was 46.9, 2.5 feet lower than

1898. Hence it will be seen that nearly every year between 500 and 600 square miles of the finest land in the delta will be overflowed. This overflow could practically all be shut off by extending the levee from Eagle Lake down to and across the old mouth of the Yazoo (now rapidly silting up since the Yazoo has been diverted) to a junction with the levee being built on Kings Point in connection with the Yazoo diversion canal. This would be an example of the complete closure of a basin. There is one objection, however, which might prove to be a serious one; that is, the end of the levee at present is built so close to the Yazoo diversion canal that it is not certain that enough cross-section area is left to carry the Yazoo at flood stages, and it is absolutely certain that if the levees were closed up down to this point, in the event of a crevasse anywhere in the Upper or Lower Yazoo basin, the opening would not be sufficient to pass this water without impounding it to some extent. This latter objection could hardly be urged seriously, however, because a certainty of overflow at 47 feet on the Vicksburg gauge always exists if the levee is never extended; whereas if the backwater is shut out it is hardly possible that any crevasse overflow would be more than the present backwater overflow.

I call attention to the possibility of this levee extension not with the idea that it is now feasible or practicable, but it is almost certain to come up for serious consideration within the next few years. A survey was made in 1893 by the United States for an extension to the mouth of the Yazoo (as it existed then), under the direction of Capt. C. McD. Townsend, Corps of Engineers. For his report and recommendations, see Annual Report of Chief of Engineers, 1894, p. 2923.

This survey would be of no use in studying the situation at the present time. I think it would be well to make a new and thorough survey from Eagle Lake to Kleinston, if practicable and if funds are available, this fall.

CONDITION OF LEVEE LINE AND ESTIMATE FOR CONTINUED CONSTRUCTION.

The profile of high-water slopes submitted shows the elevation of the top of the levee line throughout the district, and also shows net grade of all work under contract by the United States and levee board on May 1, 1904. It will be noted that there is still much levee below Greenville less than a foot above the 1903 water level, and that above Greenville the line averages at least two feet above the 1903 water.

The policy was adopted, when the project for 1904–5 was made up, of putting the entire line at least 2 feet above the 1903 water; to build standard enlargement along all exposed reaches, and to construct a topping to grade with 4-foot crown, 3 to 1 slope on land side and 2 to 1 slope on river side along reaches not exposed to wave-wash and where a good section already exists.

The project for 1904–5 covers this from Greenville to station 1370, and the levee board has topped and enlarged from stations 1370 to 1600, and from stations 4015 to 4215.

Below is given an approximate estimate for continuing this work, as outlined down to the end of the levee district.

Stations.	Miles below Cairo.	Kind of work.	Estimated contents.
			Cubic yards.
1600–2430	503–527 L	Topping	150,000
2580–3140	530–535 L	Enlargement	450,000
3240–3400	537–542 L	Topping	24,000
3400–3490	542–544 L	Enlargement	35,000
3590–3800	545–552 L	Topping	35,000
3940–4015	554–555 L	Enlargement	40,000
4260–4894	559–569 L	Topping	100,000
4962–5200	570–573 L	do	40,000
5200–5587	573–575 L	Enlargement	100,000
			974,000

974,000 cubic yards, at 20 cents, = $194,800.

This work should be undertaken just as soon as the necessary funds can be made available.

The following new levees to cover caving banks will probably be necessary before 1906:

Stations.	Miles below Cairo.	Locality.	Estimated.		
			Contents.	Price.	Cost.
			Cu. yds.	*Cents.*	
2430-2580	527 L.	Island 92	450,000	18	$81,000
4200-4260	555 L.	Shiloh	250,000	16	40,000
4894a-4962	569 L.	Albemarle to Chotard	600,000	18	108,000
					229,000
Amount necessary for enlargement and topping					194,800
Amount that could be profitably expended during 1904-5					423,800

I have received a statement from Mr. C. H. West, chief engineer of the Mississippi levee board, relative to the condition of the funds of that board and the amount they will have for work not yet contracted for. I append hereto his communication in full:

GREENVILLE, MISS., *May 4, 1904.*

Mr. A. M. TODD,
U. S. Assistant Engineer, Memphis, Tenn.

DEAR SIR: Your letter of the 2d instant received, and I give below the information you desire relative to the liabilities and resources of the Mississippi levee district.

Liabilities, May 1, 1904, to July 1, 1905.

Overdraft at First National Bank	$73,198
Certificates of indebtedness and interest	159,000
Interest on bonds for the 14 months	135,000
Work under contract	687,000
Work authorized	125,000
Rights of way, estimated	130,000
Longwood revetment, estimated balance	6,000
Cost of collecting all taxes	8,500
Salaries and office expenses	16,000
Guarding levee	4,320
Total	1,344,518

Resources, May 1, 1904, to July 1, 1905.

Bonds authorized by act of February 25, 1904	$1,000,000
Revenues for the 14 months, estimated	325,000
Total	1,325,000

Deficit by July 1, 1905, as shown by statement, $19,518. The above statement is made for the fourteen months from May 1, 1904, to July 1, 1905, it being impossible to estimate separately the liabilities that may be incurred between the 1st of May and the 1st of July of this year. No estimate is included in the list of liabilities for probable high-water expenses or for repair work that may become necessary.

Some of the items are merely estimates, and may be larger or smaller than those given; particularly is this so in the case of the items for rights of way and for revenue for the next fourteen months.

The board is authorized to increase the ad valorem tax and also the cotton tax, but whether or not this will be done will not be determined until the annual meeting of the board in July next.

Trusting that the above gives the information you desire,

Very respectfully,

C. H. WEST,
Chief Engineer.

It will be seen that the levee board proposes to contract for work covering $125,000. This amount will construct the new levees at Island 92 (527 L.) and at Shiloh (555 L.), leaving the Albemarle loop (569 L.) unprovided for, which, together with the necessary enlargement, will require approximately $300,000.

COMMISSION GRADE.

The estimate given in last year's report of yardage required to bring the line up to the Commission grade did not include the contracts let prior to May 1, 1903; very little effective enlargement has been added to the line during the season, hence the estimate as given in last year's report of the Mississippi River Commission, page 250, is very nearly correct. The Commission grade should be modified from Eutaw (433 L.) south to the end of the district, and a reestimate made, which would probably materially increase the estimate as given.

The expenditure of Government funds in this district during the period May 1, 1903, to April 30, 1904, aggregates as follows:

Designation.	Expenditures.	Per cent.
Construction	$328, 606. 60	89
Repairs and maintenance	25, 296. 87	7
Engineering, surveys, etc	17, 214. 53	4
	371, 118. 00	100

The following blueprints and statements accompany this report:

Statement of levee construction by the United States.

Statement of levee construction by the Mississippi levee board.

Statement of rainfall at Greenville.

Map showing overflow at lower end of Lower Yazoo district.

Profile showing high-water slopes, 1897, 1898, 1903, and 1904.

Respectfully submitted.

A. Miller Todd,
Assistant Engineer.

Capt. E. W. Van C. Lucas,
Corps of Engineers.

Levee work in Lower Yazoo levee district, above Greenville, May 1, 1903, to May 1, 1904.

[N.=new; E.=enlargement.]

Stations.	Miles below Cairo.	Contractor.	Cubic yards in contract.	Cubic yards added by levee board.	Cubic yards placed during year.	Total laborers.	Total teams.	Total scrapers
1038-1080	380 L.	M. J. Roach & Co	158, 948	16, 132	[a]175, 080	6, 270	5, 118	902
1080-1116	380 L.	do	165, 677	15, 878	[b]181, 555	8, 300	6, 498	3, 709
1116-1150	380 L.	do	147, 488	15, 432	[c]161, 948	7, 145	5, 602	2, 541
1150-1183	380 L.	do	161, 964	16, 128	[d]105, 318	5, 731	4, 244	2, 664
1183-1226	380 L.	do	163, 378	16, 980	[e]180, 358	7, 713	5, 646	3, 758
1840-2070	402 L.	Lowrance Bros	160, 000		67, 892	2, 297	1, 847	1, 169
2130-2230	403 L.	do	69, 500		35, 878	1, 263	970	598
3100-3125	434 L.	M. J. Roach & Co	150, 655	12, 508	[f]69, 577	3, 749	2, 776	1, 434
3125-3156	434 L.	do	151, 775	18, 386	[g]59, 640	3, 071	2, 332	1, 518
3189-3229	434 L.	do	150, 000	16, 835	[h]15, 563	694	582	346
3229-3245	434 L.	do	142, 000	14, 198	[i]14, 465	513	397	291

Amounts paid for by Mississippi Levee Board:

[a] 16,132 cubic yards.
[b] 15,878 cubic yards.
[c] 15,432 cubic yards.
[d] 16,128 cubic yards.
[e] 16,980 cubic yards.
[f] 4,648 cubic yards.
[g] 8,938 cubic yards.
[h] 1,508 cubic yards.
[i] 1,199 cubic yards.

Levee work in Lower Yazoo levee district, above Greenville, May 1, 1903, to May 1, 1904—Continued.

Stations.	Miles below Cairo.	Total traction engines.	Total wagons.	Yards per team.	Yards per scraper.	Price per cubic yard.	Average height.	Average haul.	Kind of work.
						Cents.	*Feet.*	*Feet.*	
1038-1080.....	380 L.	322	2,302	[a]23	[a]32	13.89	15.3	225	N.
1080-1116.....	380 L.	52	334	[a]26	[a]42	13.89	16.7	225	N.
1116-1150.....	380 L.	132	929	[a]24	[a]37	13.89	15.6	275	N.
1150-1183.....	380 L.	....	....	25	40	13.89	17.7	225	N.
1183-1226.....	380 L.	....	....	32	48	13.89	12.8	175	N.
1840-2070.....	402 L.	....	....	37	58	18.0	18.7	125	E.
2180-2230.....	403 L.	....	....	37	60	17.9	18.7	150	E.
3100-3125.....	434 L.	....	....	25	40	19.7	18.8	360	N.
3125-3156.....	434 L.	....	....	26	39	19.7	17.2	375	N.
3189-3229.....	434 L.	....	....	29	45	19.7	15.1	400	N.
3229-3245.....	434 L.	....	....	36	50	19.7	24.1	300	N.

[a] Traction engine and grader force worked in connection with scraper outfits, and it was impossible to determine accurately the traction engine and wagon yardage; but the traction engines are estimated to have been equivalent to 8 teams each, and the wagons to 2 wheel scrapers each, and are figured into the team and wheel scraper average accordingly.

Levee work in Lower Yazoo levee district below Greenville, May 1, 1903, to May 1, 1904.

[E. = Enlargement; B. = Banquette; N. = New; B. E. = Banquette enlargement.]

Stations.	Miles below Cairo.	Contractor.	Cubic yards in contract, United States.	Cubic yards added by levee board.	Cubic yards placed during year.	Total laborers.	Total teams.	Total scrapers.
100-200.......	480 L.	Walker Stansell.......	30,000	....	19,930	819	594	387
140-177.......	480 L.	.....do.................	112,316	....	112,316	4,873	3,651	2,336
177-210.......	480 L.	.....do.................	140,433	....	140,433	6,500	4,920	3,193
600-790.......	496 L.	.....do.................	110,106	....	106,597	4,125	3,180	1,872
1346-1730.....	500 L.	.....do.................	100,000	100,000	[a]127,872	5,759	4,061	1,951
1730-2108.....	505 L.	.....do.................	69,682	33,922	[b]78,516	2,969	2,159	1,338
2572-2880.....	531 L.	Lowrance Bros.......	58,489	61,400	[c]52,413	3,308	1,860	1,088
3800-3940.....	552 L.	L. C. Dulaney.........	115,998	....	91,433	3,434	2,376	1,419
4670-4725.....	565 L.	Israel R. Bobbitt.....	137,110	....	11,427	335	225	153
4780-4890.....	568 L.	Geo. H. Lowrance....	57,349	....	57,349	2,152	1,661	989
4854-4879.....	568 L.	Lowrance Bros.......	96,108	....	96,108	4,020	2,756	1,748
4890-5000.....	569 L.	Donovan & Daley....	74,467	....	52,947	2,613	1,969	1,269
5000-5170.....	570 L.	Morgan & McCarten.	74,665	....	74,665	4,256	2,923	1,965

Stations.	Miles below Cairo.	Total traction engines.	Total wagons.	Yards per team.	Yards per scraper.	Price per cubic yard.	Average height.	Average haul.	Kind of work.
						Cents.	*Feet.*	*Feet.*	
100-200.......	480 L.	....	....	34	52	15.74	15.0	125	E.
140-177.......	480 L.	....	32	31	47	15.74	14.0	175	N.
177-210.......	480 L.	....	....	29	44	15.74	15.6	250	N.
600-790.......	496 L.	....	....	34	57	15.74	12.1	175	E.
1346-1730.....	500 L.	65	703	[d]28	[d]38	15.74	11.9	275	B. E.
1730-2108.....	505 L.	....	....	36	59	15.74	6.2	225	B.
2572-2880.....	531 L.	....	....	28	48	16.5	6.5	200	B.
3800-3940.....	552 L.	....	....	39	64	19.87	16.8	200	E.
4670-4725.....	565 L.	....	....	51	75	15.95	12.1	175	N.
4780-4890.....	568 L.	....	....	34	58	23.0	14.5	250	E.
4854-4879.....	568 L.	....	....	35	55	21.5	15.6	250	N.
4890-5000.....	569 L.	....	....	27	42	19.4	14.4	275	E.
5000-5170.....	570 L.	....	....	26	38	19.875	13.1	275	E.

[a] 63,177 cubic yards paid for by Mississippi levee board.
[b] 33,922 cubic yards paid for by Mississippi levee board.
[c] 29,529 cubic yards paid for by Mississippi levee board.
[d] Traction engine and grader force worked in connection with scraper outfits, and it was impossible to determine accurately the traction engine and wagon yardage, but the traction engines are estimated to have been equivalent to 8 teams each and the wagons to 2 wheel scrapers each, and are figured into the team and wheel scraper average accordingly.

Table showing levee construction by the Mississippi Levee Board May 1, 1903, to May 1, 1904.

[E.=Enlargement; B.=Banquette; T.=Topping; N.=New.]

Stations.	Miles below Cairo.	Cubic yards in contract.	Cubic yards placed during year.	Price per cubic yard.	Extras paid.	Total expended.	Kind of work.
				Cents.			
0-260	365 L.	34,617	18,008	22.0		$4,508.92	T.
295-306	371 L.	3,593	3,593	21.5		[a] 772.49	N.
0-502	370 L.	2,968,300	158,182	19.7		26,487.58	N.
861-1016	380 L.	511,782	28,748	22.0	$449.70	7,591.15	B.
861-1016	380 I.	6,039	5,533	22.0		1,233.96	T.
1016-1340	385 L.	4,776	4,465	22.0		992.56	T.
1038-1226	393 L.	80,550	80,550	13.89		[b] 11,188.39	B.
1329-1340	395 L.	5,789	5,789	21.24		1,229.58	E.
1340-1550	395 L.	122,216	72,196	22.0		17,533.78	E.
1380-1511	395 L.	52,684	38,812	22.0	721.02	9,829.31	B.
1467-1511	398 L.	10,551	10,551	32.0		[c] 3,376.32	B.
2683-2853	415 L.	76,325	51,025	22.0		12,060.40	B.
2710-2787	418 L.	4,560	4,560	22.0		1,003.20	T.
3100-3245	434 L.	61,927	16,293	19.7		[b] 3,497.36	B.
3394-3650	440 L.	26,651	26,651	(d)		9,775.18	T. and N.
3410-3500	440 L.	87,658	71,280	22.0		16,222.07	E. and B.
3500-3562	442 L.	83,283	51,453	22.0		12,370.05	E. and B.
3562-3602	445 L.	42,154	42,154	22.0		9,273.88	E. and B.
3850-3981	455 L.	93,294	19,022	22.0		3,557.11	E.
3981-4151	475 L.	34,721	14,964	22.0	1,843.50	4,867.08	T.
4182-4200	478 L.	900	900	(e)		286.00	T.
4200-32	480 L.	144,593	81,924	22.0	25,978.62	48,683.93	E. and B.
32-140	480 L.	46,762	46,762	19.0		8,884.78	B.
843-940	490 L.	102,998	52,284	22.0		13,176.04	E.
1127-1137	495 L.	1,845	1,845	(f)		600.00	(h)
1370-1608	500 L.	21,710	21,710	(f)		6,549.00	T.
1346-1730	500 L.	100,000	63,177	15.74		[b] 8,949.65	B.
1730-2108	512 L.	33,922	33,922	15.74		[b] 5,339.32	B.
2572-2880	531 L.	61,400	29,529	16.5		[b] 5,398.16	B.
3165-3203	538 L.	47,445	47,445	(g)		11,287.20	N.
3135-3225	538 L.	335,748	97,744	14.0		11,631.54	N.
3480-3486	545 L.	500	500	(d)		113.75	E.
3491-3587	545 L.	375,143	375,143	27.0		101,288.61	N.
4013-4243	550 L.	99,280	69,161	22.0	45.42	12,971.56	B.
4013-4243	550 L.	70,394	66,365	31.0		17,487.18	T. and E.
4332-5232	572 L.	26,031	26,031	(f)		5,682.00	T. and E.
Total		5,320,091	1,738,266		29,038.26	415,699.09	

[a] Sublevee, below grade.
[b] Under Government contract and paid by Board.
[c] Subbanquette and filling old pits.
[d] Day force, $6.50 per team.
[e] Day force, $5.50 per team.
[f] Day force, $6 per team.
[g] Emergency loops, day force, $5.50 per team.
[h] Repair work.

Rainfall at Greenville, Miss., from May 1, 1903, to May 1, 1904.

Months.	1903.	Mean, 1886-1904.	Months.	1904.	Mean, 1886-1904.
	Inches.	*Inches.*		*Inches.*	*Inches.*
May	2.42	3.61	January	2.47	4.84
June	2.07	3.67	February	1.23	4.26
July	4.50	4.21	March	5.41	5.84
August	5.34	3.49	April	3.45	3.89
September	.38	2.91			
October	.50	2.00	Total	32.25	46.31
November	.27	3.69			
December	4.21	3.90			

APPENDIX 2 N.

REPORT OF MR. E. C. TOLLINGER, ASSISTANT ENGINEER, ON LEVEES IN THIRD DISTRICT, ARKANSAS AND LOUISIANA, DURING SEASON 1903–4.

MEMPHIS, TENN., *May 1, 1904.*

CAPTAIN: I have the honor to submit the following report of operations in the Upper Tensas levee district, from May 1, 1903, to May 1, 1904:

The limits of the district, together with a brief description of the location of the different systems, will be found in the Annual Report of the Chief of Engineers for 1900, pages 4854 and 4855, the only change to be noted being an extension of the Arkansas River system from stations 732 to 783 on the Dry Bayou location.

The total length of the line in this district on May 1, 1903, was 186.7 miles, containing 29,092,868 cubic yards, 21,956,421 cubic yards being credited to the United States and the remaining 7,136,447 cubic yards to the local boards.

During the year there have been added by the United States 677,090 cubic yards, and by the local boards 1,808,210 cubic yards, making a total for the year of 2,485,300 cubic yards.

During the year 8,330 linear feet of new levee in Arkansas and 16,038 linear feet in Louisiana have been constructed, throwing out 23,639 linear feet of old levee, containing 794,042 cubic yards, leaving the total length of the levee line in the district, May 1, 1904, 186.7 miles, containing 30,784,126 cubic yards, 22,633,511 cubic yards being credited to the United States.

Abandoned levees.

Local name.	Station.	Length.	Cubic yards.
	Arkansas.		
Leland Loop	2087+28–2067	7,637	232,111
Do	2171 –2258	2,000	27,702
	Louisiana.		
Hollybrook	1809–1854	4,500	228,610
Mascot	3013+50–3045+10	3,160	37,825
Martin & Biggs	4421+70–4485+12	6,342	267,794
Total		23,639	794,042

During the past season the following bids were accepted for levee work:

Bids opened August 18, 1903.

Stations.	Miles below Cairo.	Awarded to—	Price.	Kind of work.
		In Arkansas.	*Cents.*	
0–62+50	470 R.	Dulaney & Leonard	19.35	New spur.
2170–2185	470 R.	....do	17.25	New loop.

Bids opened April 13, 1904.

		In Arkansas.	*Cents.*	
500–655	(a)	Jno. G. Sessions	17.74	Enlargement.
2580–3760	497 R.	Ben Talley & Co	20.00	Topping.
3760–3950	512 R.	....do	20.00	Enlargement.
		In Louisiana.		
1539–1810	545 R.	Ben Talley & Co	18.5	Enlargement.
4459–4549	605 R.	H. Dalhoff	24.6	New loop.

[a] Arkansas River.

WEED CUTTING.

Owing to scarcity of funds and light growth of weeds on the levee, no weeds were cut during the season except through the Vaucluse field, stations 2488 to 2533.

ARKANSAS RIVER LEVEES.

On pages 4857 and 4858 of the Annual Report of the Chief of Engineers for 1900 will be found a brief description of the conditions and needs of the Arkansas River levees and the relation of this system to the Mississippi River levee system. No new contracts having been made during the season for the further extension of this line, the gap of 6.05 miles between the lower end of the Arkansas River system and the main line of levees at Boggy Bayou remains as it was in the last report. The safety and general good of the district demand the closing of this gap as rapidly as possible.

CAVING BENDS.

Cypress Bend (*426 R.*).—The caving at Lucca Landing has moved up and down the bend. The old abandoned levee has caved off from stations 418 to 462, and is within 900 feet of the levee at station 484. There has been some caving from stations 630 to 750, leaving about 200 feet between the levee and the river at stations 650 and 750. A new loop will probably be needed this season.

Rowdy Bend (*451 R.*).—The shore line is within 828 feet of the levee at station 1530 and within 500 feet at station 1730. A new loop will probably be needed at this point in the next three years.

Mathews Bend (*509 R.*).—Some caving has occurred from a point opposite station 3705 to station 3755. The shore line is within 455 feet of the levee at station 3733.

Wilsons Point (*522 R.*).—Practically no caving has occurred along this stretch during the past season.

Mascot (*516 R.*).—Caving has continued at this point and is within about 200 feet of the angle at station 3032. The new loop at this point has been completed by the Fifth Louisiana levee board.

Reed (*604 R.*).—Caving has continued along this stretch, leaving about 185 feet at station 4470 and 214 feet at station 4480, between levee and river. The new loop at this point has been completed by the Fifth Louisiana levee board.

CONDITION OF LEVEES WITH REFERENCE TO 1903 HIGH WATER.

In Arkansas.—Extension Arkansas River system, total length 14.8 miles:
 1.2 per cent from 0.5 to 1.7 feet below 1903 high water.
 33.0 per cent flush with 1903 high water.
 50.0 per cent 0.2 foot above 1903 high water.
 15.8 per cent 3.0 feet above 1903 high water.
 No banquette.

Mississippi River system.—Costello gin to Louisiana State line; length, 82.9 miles:
 5.0 per cent 4 feet above 1903 high water.
 1.9 per cent 2 feet above 1903 high water.
 24.6 per cent 2 feet above 1903 high water.
 36.2 per cent 1 foot above 1903 high water.
 24.4 per cent 0.5 foot above 1903 high water.
 2.0 per cent topped 1 foot above 1903 high water.
 5.9 per cent topped 2 feet above 1903 high water.
 32.3 per cent has banquette.
 67.7 per cent has no banquette.

In Louisiana.—Length of line from Arkansas State line to lower end of district, 8 miles:
 9.1 per cent 5 feet above 1903 high water.
 8.0 per cent 4 feet above 1903 high water.
 21.3 per cent 3 feet above 1903 high water.
 41.9 per cent 2 feet above 1903 high water.
 11.3 per cent 1.6 feet above 1903 high water.
 8.4 per cent 0.5 foot above 1903 high water.
 58.8 per cent has banquette.
 41.2 per cent has no banquette.

Estimated yardage to bring the entire line to a grade of 2 feet above high water of 1903 with standard section.

Stations.	Enlargement.	New levee.	Banquette.	Total.	Remarks.
In Arkansas.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*	
0-783 [a]	755,000	....	237,600	992,600	Enlargement of Arkansas River levees.
783-1087	....	1,301,800	175,000	1,476,800	Extension of Arkansas River levees.
0-269	567,700	[b] 458,700	1,352,800	2,379,200	Amos Bayou.
0-4210					Main line.
Total	1,322,700	1,760,500	1,765,400	4,848,600	
In Louisiana.					
0-4619	474,000	[c] 558,000	1,226,700	2,258,700	
Grand total	1,796,700	2,318,500	2,992,100	7,107,300	

[a] Stations 655 to 783 built to a grade 3 feet above 1897 high water without banquette.
[b] New loop with banquette at Grand Lake and new loop at Panther Forest without banquette.
[c] New loop with banquette at Biggs.

Estimate for ultimate Commission grade.—This is based on the average of new Commission grade at White River and Arkansas City; Arkansas City and Greenville; Greenville and Lake Providence, and Lake Providence and Vicksburg, and applying these averages to the local high water along the line between these respective points, thus giving the following approximate estimates in Arkansas and Louisiana.

IN ARKANSAS.

Stations.	Kind of work.	Cubic yards.	Price.	Total cost.	Remarks.
			Cents.		
0-655	Enlargement	1,066,015	18.8	$200,410.82	Arkansas River levees.
655-783	do	184,000	18.8	34,592.00	Do.
783-1087	New levee	1,826,044	20.0	365,208.80	Do.
0-1087	Banquette	688,635	15.0	103,295.25	Do.
Total	....	3,764,694	....	703,506.87	
0-269	Enlargement	4,369,035	18.8	821,378.58	Amos Bayou line.
0-4210					Main line.
600-816	New levee	1,249,279	16.0	199,884.64	Covers stations 600 to 900.
1700-1760	do	274,400	20.0	54,880.00	
3690-3767	do	280,000	20.0	56,000.00	
0-4210	Banquette	1,756,165	15.0	263,424.75	
Total	....	7,928,879	....	1,395,567.97	

IN LOUISIANA.

0-4619	Enlargement	4,541,386	18.8	853,780.57	
0-4619	Banquette	2,107,220	15.0	316,083.00	
4459-4549	New levee	576,000	25.0	144,000.00	
Total	....	7,224,606	....	1,313,863.57	

Summary.

	Cubic yards.
Extension and enlargement of Arkansas River levees	3,764,694
Arkansas main line	7,928,879
Louisiana	7,224,606
Total cubic yards	18,918,179

Total cost, $3,412,938.41.

The estimates show that there is still required 755,000 cubic yards to bring the Arkansas River levees from stations 0 to 783 up to the 2 feet grade with standard section, 1,301,800 cubic yards for the extension of this levee to station 1087 on Cypress

Creek (opposite station 81 on the main line), and 412,600 cubic yards for banquette for the above stretches of levee from Red Fork to Cypress Creek, leaving 3,621,200 cubic yards to cover the main line in Arkansas and Louisiana, and 1,016,700 cubic yards for the new loops at Panther Forest, Grand Lake, and Biggs.

ARKANSAS RIVER LEVEE IMPROVEMENT.

The Arkansas levees in the Red Fork levee district extend from the Lincoln-Desha County line to the beginning of the Government levee just below Red Fork, having a length of about 14 miles. During the past year only a few minor repairs have been made by the levee board.

SURVEYS.

Surveys of the Arkansas River levee line and the Louisiana levee line below Lake Providence have been made. Surveys for the extension of the Arkansas River line and for new loops at Grand Lake (509 R.), Mascot (577 R.), and Reeds (604 R.), including the tracing of the shore lines adjacent to these new loops, have been made. Distances from the levee to the caving banks in close proximity have been measured and reported monthly.

High-water marks have been established and elevations recorded, and the limits of the overflowed district back of the Arkansas River levees have been obtained.

I would recommend that surveys for drainage, both back and front of the levees, and also surveys of the narrow necks between the levees and the river, be made. The importance of such surveys is, of course, dependent on the importance of these subjects, which are discussed elsewhere in this report.

PREVAILING CONDITIONS.

Weather.—The weather has been remarkably favorable throughout the year, causing very little loss of time or extra work, even during the winter months, which are usually so wet.

High water of June, 1903.—The rise in June, 1903, was higher than the usual June rise, registering 39.8 at Greenville, or 9.3 feet less than the highest record March 27, 1903. This June rise filled all the borrow pits on the river side of the levees and delayed work on enlargement contracts and unprotected new loops. Work on the new loop at Leland, being behind the old levee which was still intact, was not delayed very much from this cause. A very strenuous effort was made by the Fifth Louisiana levee board to build a temporary loop around the gap at Hollybrook that had been made by the overflow of April, 1903. A great deal of money was spent in the endeavor, and success seemed so probable that work was continued until the loop was breached. Had this flood been anticipated earlier a great loss would have been obviated. The area overflowed was about the same as that resulting from the April crevasse, but the damage wrought by this later flood of June was very disastrous on account of being too late to be followed by replanting.

The height of the river from July, 1903, to March, 1904, is remarkable for its uniformity, there being no very low water and none above danger line during the period.

STAGES AND SLOPES OF 1904 HIGH WATER.

The highest flood of the year culminated in April, 1904. The heights attained by it between Cairo and Vicksburg are shown in the following table of maximum heights for the years 1897 to 1904.

Maximum gauge readings, 1897 to 1904.

Miles below Cairo.	Station.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.
0	Cairo	51.6	49.8	46.2	39.2	43.2	42.1	50.6	49.1
230	Memphis	37.6	37.6	35.2	29.5	32.1	30.9	40.1	39.0
306	Helena	51.8	49.1	46.8	38.1	41.6	39.6	51.0	47.7
353	Sunflower	47.2	46.0	44.3	37.1	40.5	38.8	48.0	44.5
393	Mouth White River	46.0	51.5	48.5	40.8	44.7	43.2	53.7	49.5
438	Arkansas City	51.9	51.1	48.8	39.2	43.3	41.4	53.0	49.0
478	Greenville	46.8	46.2	43.0	33.8	37.4	36.0	49.1	43.5
542	Lake Providence	44.5	44.4	41.7	33.0	36.5	35.0	46.5	42.5
599	Vicksburg	52.5	49.4	47.8	38.0	41.5	41.2	51.8	46.9

A table of elevations of this high water at points in this district is appended to this report. Observing the difference between the high waters of 1903 and 1904 at Greenville (478 R.), as shown by the above table, and the difference between the same high waters at Luna, Ark. (467 L.), it will be noted that the maximum stage was relatively lower this year than last year. The direction of the currents, and especially the surface currents, changes very much as the river rises, particularly after the danger line has been past. These changes affect the local slopes, and hence some of this change of slope may be ascribed to the difference in the directions of the currents prevailing at these stages.

Another cause is probably the difference in the condition at Leland. Across this neck the current is at a high velocity, being about 15 feet deep and having a slope of 4 feet in about 3,000. The strength of this current was so great that a channel was cut nearly all the way across this neck. After passing over the neck this torrent flowed out into the channel of the main river. Taking the width of the river as being from levee to levee, as is the case in a great measure and may be so regarded in the consideration of surface currents, the river is several miles wide from Arkansas City to Leland, and had here a narrow outlet almost at right angles to the general direction of the broad river above. It was above this narrow outlet that the current from across the neck threw itself directly across the path of the main current of the river. Thus, as an obstruction, it dammed the river above, increasing its pressure against the leeves, and, as a direct force, it changed the direction of the currents for some distance below. During the year a spur levee 6,350 feet long has been built along this neck to prevent this current from flowing across it. The effect of this has, no doubt, been to lessen the obstruction at the upper end of the narrow outlet at Lower Leland.

HIGH WATER OF 1904.

The high-water inspection was distributed as follows:

Arkansas River levees under Overseer B. Baumgarden, who reported to the Greenville office.

Mississippi River levee.—Costello Gin to Gaines Landing, Ark., under Inspector T. S. Shields, at Arkansas City, Ark. Gaines Landing to State line under Inspector P. L. Lowe, Greenville, Miss. State line to station 1986 (below Hollybrook) under Inspector John J. Hoopes, Lake Providence, La. Station 1986 to end of district, under Fifth Lousiana levee board, J. T. McClellan, president, Tallulah, La.

A sufficient number of inspectors were employed to have the whole line inspected daily. They were instructed to report and note defects promptly, and, when necessary, to have work done on them at once. While the situation did not prove at all serious, this organization was a benefit to the service, for many of the men thus employed will probably be employed similarly in later years, and, besides becoming familiar with the methods of the work, will keep posted on the condition of the levees. Besides, this office has a better knowlege of the condition of the levees and of the men available for similar organization in future emergencies.

People along the line regarded this move very favorably, because of their confidence in the efficiency of the system and methods that obtain in this district.

Before the flood had reached the danger line, small forces were put on the Arkansas River levees and the Leland spur levee to complete the revetment at the ends of these levees and then to attend to the high-water protection work most needing their attention. About 1,000 sacks were used in weighting this revetment. The force on the Arkansas River levees also cut weeds off the levees and built some false berms through sloughs in which trouble was experienced last year.

The force on the Leland spur, after completing the revetment, had to protect the levee from wave wash and from a slough which occurred where the levee crossed a deep hole. One thousand sacks in all were used in this spur levee.

The end of the spur levee at station 750 (433 R.), the Middle Place front (432 R.), and the road crossing at the angle at station 4044 (515 R.) had to be sacked, using 600, 400, and 3,000 sacks, respectively, at these points.

Small drains were cut across the berm, stations 755 to 1060, in Louisiana, to carry off the seep water.

EFFECT OF HIGH WATER ON REPAIR WORK.

The effect of this high water upon repair work done by the Tensas Basin levee board after the high water of 1903 was observed and noted. These repairs consisted of the following:

At Gaines Landing (446 R.), stations 1510 to 1530, ditch cut and refilled to intercept seepage and boils. Several rotten stumps were also excavated and the holes filled.

At Panther Forest (450 R.), station 1757, ditch cut and refilled to cut off boil holes, and the land-side borrow pit, into which the ditch had issued, filled for a length of 200 feet.

At Vaucluse (487 R.), station 2533, a section about 150 feet wide (measured parallel to the levee) and 200 feet long, through which boils had issued and had given great trouble, was excavated to a depth of about 15 feet, then filled to a height of 5 feet with good material, on top of which the material previously excavated was placed, thus adding 5 feet to the height of the embankment over this area.

The observations during this high water indicated that the ditch at Gaines Landing had reduced the amount of the seepage, and that at Panther Forest and Vaucluse the embankment was saturated thoroughly, but being new work, it may be presumed that the banquette became thoroughly water-tamped and will be more impervious to the water in succeeding floods. If this presumption should prove incorrect, these embankments will have to be enlarged, and perhaps a sublevee will be required at Vaucluse.

The revetment on the end of Arkansas River levee consisted of fascines of cane, and was weighted down with sacks of earth. This work withstood the high water very satisfactorily.

The revetment on the end of Leland spur levee consisted of poles and brush fastened by wires and weighted with rock. Brush dikes were constructed to break the force of the current. No trouble was experienced in holding it in place during this high water, except that, the material being light and the current strong, holes were washed out under the revetment which required a great deal of sacking from time to time.

I would therefore recommend that during the coming year the poles and brush be taken up and the surface revetted by covering with a layer of spalls, this to be covered with a layer of larger rock, and this in turn by a layer of spalls filling the interstices and presenting a smooth surface to the current. I would further recommend that the revetment be extended farther beyond the slopes of the levee.

OVERFLOW FROM THE HIGH WATER OF 1904.

The water around the end of the Arkansas River levees backed up about 6 miles along the levee and covered an area of about 50 square miles. This territory is back of the Arkansas River levees and north of the end of the Mississippi River system of levees. The water commenced flowing through Newman Slough and around the head of the system, when a stage of about 48.5 feet was reached at Arkansas City. The bayous were not filled from this flow, hence there was no overflow behind the Mississippi River levees.

LABOR.

The scarcity of labor was the great drawback of the year. This was owing to the great amount of work being done throughout the country, not only making the demand greater than the supply, but making labor more independent and exacting. Locally there appeared to be more sickness than usual, probably owing to the overflows in the vicinity.

The introduction of graders reduced the demand for labor while they were kept in order, but increased it very much and very suddenly when they broke down.

Meeting the demands of labor, and increasing the health of laborers, are subjects for the social and sanitary engineer, respectively, but there is probably some room for improvement in both respects.

NEEDS OF THE LEVEES.

Additions.—The levees are neither long enough, wide enough, nor high enough.

The levee in most need of an enlargement of all these dimensions is the Arkansas River line. It is so low and narrow that a high water one-half a foot higher than that of 1903 would submerge 12.4 of its 14.8 miles of levee. It is so short that there is a gap of 6.05 miles between it and the head of the Mississippi River levees. The water through this gap flanks both systems, and floods a part of the districts behind them. Even if all the people can not be protected all the time, they should be protected at least some of the time.

An estimate of the yardage required to bring the levees to a grade 2 feet above the high water of 1903, and also an estimate for bringing them up to the Commission grade, is included in this report.

New loops.—An estimate of the new loops that will probably be required in the next five years follows:

Local name.	Stations.	Miles below Cairo.	Length.	Cubic yards.	Price.	Cost.
Lucca	424- 529	428 R.	7,000	305,500	$0.20	$61,100
Middle Place	620- 785	430 R.	12,500	540,800	18	97,344
Gaines Landing	1510-1550	450 R.	3,200	123,300	18	22,194
Grand Lake	3690-3806	509 R.	12,900	602,100	20	120,420
Wilson Point	900-1066	531 R.	14,400	430,000	18	77,400
Total				2,001,700		378,458

NOTE.—Grade 2 feet above 1903 high water; with banquette.

These changes have been necessitated by caving banks in all instances. In this way large expenditures are made that do not add to the height or width of the levee, but only change them to a less dangerous location.

A back line extending north from Arkansas City was recommended over ten years ago. Since that time the old levee in front of this proposed loop has been enlarged from time to time by the local levee boards until more funds have been expended on such enlargement than would have built the back line originally recommended.

At Biggs and Reeds $60,000 was expended on temporary loops in 1903-4, which loops will have to be replaced by new ones in 1904-5. This was at least partly owing to the levee boards not having sufficient funds to build them on a more permanent location. There was a very rapid caving at this point recently, which rendered it necessary to construct one after the other of these loops as quickly as possible. A more permanent loop has been placed under contract, to be finished February 1, 1905.

The caving at Mathews Bend is so threatening that a new loop will certainly be required at Grand Lake (509 R.) soon. Two alternate levee projects have been presented to meet this emergency. The longer line, estimated to cost $120,420, would leave all the town of Grand Lake unprotected, but would add a few more years to the life of the levee. Anything like a permanent location should be on the line along the west bank of Grand Lake. An estimate for this line, submitted June 1, 1902, gives the length of this loop at 36,600 feet; estimated cost, $269,535; land thrown out, 7,800 acres, which would, of course, include the town of Grand Lake. Besides this, the plantations would be greatly damaged, since the residences and other buildings on them are located near the west bank of this lake, along the proposed line of levee. The damages to be paid for right of way, added to the above estimated cost of construction, would make this a very expensive project. It is therefore suggested that a revetment would be a much more economical solution of the problem. The line of this part of the present levee was located under Capt. C. McD. Townsend, Corps of Engineers, who was convinced that when this levee was again threatened by caving, the banks should be revetted.

Spur dikes.—All points having narrow necks, and perhaps all points that would otherwise have no levees on them, should have spur levees on at least a part of their length, their initial point being at a junction with the main levee. The policy of building short lines of levees, and leaving the points unprotected, is certainly a mistaken one, unless the addition of these spur levees is to be included in the plan. The principal object of these dikes would be to prevent cut-offs, which would cause the levee to be menaced by caving at so many unexpected points. The building of these dikes, if of proper length, location, and stability, would also tend to give the high-water slopes a greater uniformity, the currents a greater regularity, and the location of the channel more stability.

A spur levee was built at Leland (470 R.) during the past year. This was to prevent a cut-off across that neck, a danger that was averted by a very narrow margin during the high water of 1903. That its construction was in the interest of the levee system can not be doubted. The length of this spur is 6,350 feet, the end of it being curved, extending into thick timber, and well revetted. It withstood this year's high water very well, except that the material being light and the slope steep, it showed a weakness in resisting wave wash, and a tendency to slough. I would recommend that the spur be further extended in the near future, and ultimately to the end of the point.

A short spur levee will also be needed at about station 4040 (515 R.) to prevent the levee from being washed away at the angle near that point, around which the current sweeps at a rapid rate.

Funds.—As at Biggs and Reeds, much money could be saved if there were sufficient funds available to build the levees to the proper grades and on permanent locations in time to meet the emergencies as they arise.

Standards.—In my report for 1903, a few slight modifications of present standards were suggested. These will be found in supplement to Report of the Chief of Engineers for 1903, pages 262 and 263. A few more suggestions on the subject are added below.

Forty feet would seem to be a sufficient width for berm until the location of the levee becomes more permanent than it has yet proved to be. But when the levees shall have been permanently located, the berm should be thoroughly grubbed and a false berm built, which should have flat slopes, extend into the borrow pits, and be well dressed and sodded.

Traverses in the borrow pits should be cut as far from the levee as possible to avoid directing the currents toward the levees or causing erosion near it. Levees subject to wave wash should have a flat slope on the river side. Beyond the borrow pits of such levees, right of way should be secured and trees planted on it.

The crown of the levee should be dressed with extra care, so as to shed water uniformly.

Extension of Government inspection.—The importance of a rigid inspection of the construction of the levees is recognized by all levee authorities. Under their present system (and probably in the very nature of the case) the levee boards have not been able to have their work very rigidly inspected. They are generally very glad to have the Government inspectors inspect their work for them, which the latter can often do while inspecting Government work in the vicinity. An extension of this arrangement to much more of their work would be very advantageous to the levees, and, even if the Government should be compelled to increase its force of inspectors on that account, the additional expenditure would be well warranted.

Maintenance.—The care of the levees after they are built is very important. This will include cutting the weeds and resodding the bare places on the levee. These matters have received attention, but the resodding probably not as much as its importance demands.

Keeping travel off the levee is also an important element in its maintenance. This is generally treated as an individual offense, but where a community fails to provide roads for travel in the vicinity of the levee, it would seem to be an offense by that community. Travel has been kept off the levees in Arkansas, especially in Chicot County, much better than in Louisiana, and this fact should be taken into consideration in determining where the Government expenditures for levees should be made. In Louisiana, at least some of the people are of the opinion that certain local taxes entitle them to the use of the banquette of the levee for a roadway. Of course, if the banquette, or even if the base of the levee is to be so used, the repair of these roads should be included in the maintenance of the levee.

Location.—The proper location of the levees is one of their greatest needs. Looking only to the immediate future, and counting only the first cost, small private levees were built on the highest ground, without any regard to alignment. When the community took up the work it connected and enlarged these levees. Then, as new loops were required, due to recession of banks by caving, or to crevasses, stretches next to the older levees were made as nearly at right angles to the general alignment as possible, in order that when the loop should be again extended there would be a minimum of abandoned levee. Later, when these older levees had to be abandoned on account of defective foundations, the first cost of the new levees was kept down by short lines across points, and they sometimes swerved toward the river in order to still protect some property upon which valuable improvements had been made while being protected by the levees.

With this history in mind, the lack of system in location of levees can be readily understood. The levees are being menaced by caving banks in many places; other levees are located so near the banks of lakes and bayous that future enlargements of such levees must be on the land side; others extend to the banks of bayous and then make abrupt turns to avoid crossing them. Temporary loops have been built where they would hold but a little longer than those they replaced, because funds were not available to build them farther from the danger.

An early determination of the principles that should obtain in the location of levees is very much needed. The levees are growing higher, and the abandonment of any part of the levee means a greater and greater loss. The property behind and adjacent to the levees is becoming more and more valuable, so that changes in the location are becoming more costly. Again, if we had an ideal location of the whole system of levees—both sides of the river included in one system—so that it could be approximately determined what portion of our present levees could be regarded as on a permanent location, and where the other portions would ultimately be located, a great waste of funds could be avoided.

In considering the principles that should obtain in the location of levees, the minimum first cost must still be considered of prime importance. A greater amount of protection must be afforded before the financial support can be obtained that will be sure to come later.

Good foundations must be selected, both on account of keeping down first cost and having a permanent line.

Abrupt changes in direction should be avoided, and curves should be substituted where sharp angles can not be avoided, more especially where these angles are salient to the river.

The ideal and ultimate location of the levees has the deepening of the channel for one of its objects, and a minimum caving for another. Still another object would be to give the river as regular and uniform a slope as possible when not inconsistent with the other objects to be attained.

This proposed permanent location would require at least an approach to a uniform width between the levees of the two sides of the river. To determine this width the effect on the regimen of the river would have to be first considered, and then the amount of property that can with propriety be promised protection. The relative stretches of the river included between the levees in their several parts and the location of towns along the banks must also be well considered.

Prevention of caving and cut-offs.—Adjacent property, and commercial and navigation interests, are all concerned in the prevention of caving and cut-offs along the river. The levee system is no less so. Levees are abandoned every year on account of caving, and are threatened at this time at several points. Cut-offs not only increase the caving, both above and below, but change the direction of the currents and cause this caving at unexpected places where provision has not been made for it.

The caving at Reeds has been very great, as mentioned in discussing new loops. How much of this was caused by disturbances introduced by the cut-off near Vicksburg in 1876 can not be determined. Neither will it be known whether the cut-off at Palmyra in 1867 did not directly cause the one at Vicksburg in 1876, and this, in turn, the cut-off back into Lake Palmyra in 1904.

Whether the prevention of cut-offs will be ultimately accomplished by the proper location of the main levees on or near the neck and points or not, the present location of the levees necessitates the use of spur levees to prevent cut-offs across the narrow necks. This subject has already been discussed, however, under the head of spur dikes.

Timber on points and necks is a great protection to them and an important factor in preventing cut-offs, on account of its breaking up the currents that would otherwise sweep over them. Whatever can be done to prevent the clearing and cultivation of the land outside of the levee should be done.

Bank revetment.—Banks have been revetted at different times with the object of preserving levees endangered by caving banks, where new loops would have proved much more expensive than the revetment, or where the property thrown out by loops would have caused very great loss. This policy should be pursued whenever it is the more economical way of accomplishing the required result, and, if necessary, should be paid for out of levee funds. The value of the property from which protection would be withdrawn should also be considered.

Closer relation to channel improvements.—A more complete control of the river in the matter of scour of its bed, preservation of its banks, and confinement of floods is the object to be sought by all in the service, whether employed on channel or levee improvement. Building levees, revetting banks, and dredging channels will, if properly directed, all tend to the accomplishment of the objects mentioned. These several branches of the service should be regarded as interdependent parts of a great system, and the energies of those connected with the different branches should be directed to the most economical accomplishment of all these objects.

MISCELLANEOUS.

Railroads.—The construction of the Memphis, Helena and Louisiana Railroad has been continued both north and south, and is now being operated from McGehee, Ark. (on the St. Louis, Iron Mountain and Southern Railroad), to Clayton, La. The completion of this road northward from McGehee is dependent upon the completion of the bridges across the Arkansas and White rivers, which have been delayed by the unusually high stages of water that have prevailed in these rivers during the year. The operation of this line after completion will be impeded, if not suspended, during every high water until the gap in the levees between the Arkansas River and Mississippi River systems is closed.

Telephones.—Telephone facilities remain the same as last season. They furnish us communication with the more important points along the line.

Death of employee.—We lost a faithful and efficient employee in the death of Inspector Edwyl Llewellyn on April 8, 1904. He had been employed in this district about fifteen years.

Inclosed with this report will be found the following:

Statement of expenditures by the United States.

Statement of work done and funds expended by the Red Fork, Desha County, Chicot County, Fifth Louisiana, and Tensas Basin levee boards and the State of Louisiana.

Table showing cost of construction.[a]

Table giving comparison of high waters of 1897, 1898, 1903, and 1904.

Labor statement.

Statement of material in levees.

In conclusion, I wish to thank the local levee boards for their prompt and efficient cooperation, and my assistants for their faithful and thorough performance of duty.

Respectfully submitted.

E. C. TOLLINGER,
U. S. Assistant Engineer.

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

Levee work in Upper Tensas levee district in Arkansas and Louisiana, May 1, 1903, to May 1, 1904.

[N.=New; E.=Enlargement.]

IN ARKANSAS.

Stations.	Miles below Cairo.	Contractor.	Cubic yards in contract.	Cubic yards placed during year.	Total laborers.	Total teams.
2087-2121	470 R.	George R. Lacy	141,145	141,145	7,492	5,470
2121-2164	470 R.	Donovan & Daley	145,589	145,589	7,141	5,526
2170-2185	470 R.	Dulaney & Leonard	29,431	29,431	1,204	818
0-62+50	470 R.	do	180,852	180,852	6,448	5,204
2252-2533	486 R.	Lewis & Jennings	142,992	35,289	2,473	1,807
4080-4210	516 R.	Donovan & Daley	99,360	20,130	809	654
IN LOUISIANA.						
0-120	517 R.	Dulaney, Sessions & Leonard	107,157	107,157	5,921	4,289
120-190	517 R.	Donovan & Daley	76,969	76,969	3,022	2,295
190-256	523 R.	M. L. Linnan	69,719	69,719	2,633	2,197

IN ARKANSAS.

Stations.	Miles below Cairo.	Total scrapers.	Yards per team.	Yards per scraper.	Price per cubic yard.	Average height.	Average haul.	Kind of work.
					Cents.	*Feet.*	*Feet.*	
2087-2121	470 R.	3,567	25	39	15.7	16.5	200	N.
2121-2164	470 R.	3,622	26	40	16.0	16.4	200	N.
2170-2185	470 R.	516	36	57	17.25	12.0	150	N.
0-62+50	470 R.	2,972	35	61	19.35	15.7	150	N.
2252-2533	486 R.	1,128	19	31	21.5	13.6	150	E.
4080-4210	516 R.	367	30	54	19.7	15.1	225	E.
IN LOUISIANA.								
0-120	517 R.	2,790	25	38	19.74	18.5	200	E.
120-190	517 R.	1,487	33	52	17.25	18.5	150	E.
190-256	523 R.	1,410	31	49	17.48	21.0	150	E.

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[a] Omitted.

Statement of work done in the Upper Tensas levee district in Arkansas and Louisiana by the Desha County, Chicot County, Tensas Basin, and Fifth Louisiana levee boards, and the State of Louisiana, from May 1, 1903, to May 1, 1904.

WORK DONE IN ARKANSAS.

	Cubic yds.	Cost.
Desha County levee board:		
Stations 887-890, Arkansas City front enlargement	16,738	$1,928.60
High water protection (Chicot front)		25.00
Miscellaneous expenses		455.00
Tensas Basin levee board:		
Stations 1020-1240, Fulton Lake enlargement	161,300	55,648.50
Leland dike	129,199	25,000.00
Repair work at Panther Forest, Lucca Landing, Gaines Landing, and Vaucluse		9,630.00
Chicot County levee board:		
Topping and repairs, stations 3078-3950	10,000	6,990.00
Miscellaneous expenses		6,535.76
Total	317,237	109,212.86

WORK DONE IN LOUISIANA.

Enlargement and new levee	1,490,973	$361,644.73

RECAPITULATION.

Desha County levee board	16,738	$5,408.60
Tensas Basin levee board	290,499	80,278.50
Chicot County levee board	10,000	13,525.76
State and Fifth Louisiana levee board	1,490,973	361,644.73
Total	1,808,210	460,857.59

Work done above Red Fork, Ark., by the Red Fork levee board.

Miscellaneous expenses $2,023.87

Comparison of high waters of 1897, 1898, 1903, and 1904.

IN ARKANSAS.

Station.	Miles below Cairo (R. B.).	Elevation, high water. 1903.	Elevation, high water. 1897.	1903 high water above 1897.	Elevation, high water 1898.	1903 high water above 1898.	Elevation, high water 1904.	1903 high water above 1904.	Locality.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
0	Ark. R.	172.82	170.99	1.83	168.97	3.85	167.52	5.30	**Red Fork.**
0	405	162.88	162.88	.00	161.65	1.23	158.42	4.46	**Amos Bayou.**
495	422	159.71	159.01	.70	157.87	1.82	155.46	4.25	**Lucca Landing.**
698	431	158.48	157.95	.53	156.47	2.01	154.04	4.44	**Chicot.**
928	438	156.36	155.20	1.16	154.51	1.85	152.36	4.00	**Arkansas City.**
1511	450	152.51	151.76	.75	150.94	1.57	148.86	3.65	**Gaines Landing.**
1941	467	148.23	147.03	1.20	146.20	2.03	144.33	3.90	**Luna Landing.**
2254	486	142.46	140.26	2.20	139.89	2.57	137.36	5.10	**Leland.**
2581	487	142.07	139.87	2.20	139.57	2.50	136.97	5.10	**Vaucluse; Commission gauge No. 96.**
2742	490	141.24	138.86	2.38	138.55	2.69	136.06	5.18	**Sunnyside.**
3040	495	139.48	136.93	2.55	136.64	2.84	134.43	5.05	**Lakeport.**
3382	504	136.12	133.57	2.55	133.26	2.86	130.67	5.45	**Harwood.**
3760	516	133.87	131.55	2.32	131.44	2.43	128.55	5.32	**Grand Lake.**
4049	516	131.07	128.85	2.22	128.75	2.32	126.02	5.05	**Sterling.**
4206	520	130.69	128.44	2.25	128.44	2.25	125.64	5.05	**Louisiana State line.**

Comparison of high waters of 1897, 1898, 1903, and 1904—Continued.

IN LOUISIANA.

Station.	Miles below Cairo (R. B.).	Elevation, high water. 1903.	Elevation, high water. 1897.	1903 high water above 1897.	Elevation, high water 1898.	1903 high water above 1898.	Elevation, high water 1904.	1903 high water above 1904.	Locality.
247	523	130.25	128.00	2.25	127.90	2.35	125.35	4.90	Pilchers Point.
947	532	126.20	123.80	2.40	123.90	2.30	121.80	4.40	Wilsons Point; Commission gauge No. 87.
1207	537	124.25	122.30	1.95	122.40	1.85	120.10	4.15	Benhams.
1462	542	122.94	121.03	1.91	120.84	2.10	118.94	4.00	Lake Providence.
1815	547	122.30	120.05	2.25	120.05	2.25	118.30	4.00	Hollybrook.
1987	555	119.37	116.87	2.50	116.34	3.03	116.47	2.90	Point Lookout.
2354	561	117.17	115.67	1.50	114.99	2.18	112.97	4.20	Alsatia.
2670	565	116.02	114.22	1.80	113.16	2.86	111.92	4.10	Salem.
2815	574	112.05	110.90	1.15	109.48	2.57	107.80	4.25	Henderson.
3097	578	110.60	109.80	.80	108.00	2.60	106.30	4.30	Omega; Commission gauge No. 79.
3602	587	108.19	108.09	.10	105.55	2.64	103.79	4.40	Above Duckport.
3655	588	107.27	107.72	− .45	104.90	2.37	102.37	4.90	Do.
3940	593	106.30	107.00	− .70	103.80	2.50	101.10	5.20	Youngs Point; Commission gauge No. 76.
4222	600	105.10	105.80	− .70	102.56	2.54	99.60	5.50	Delta.
4380	603	103.20	103.20	.00	100.90	2.30	98.30	4.90	Commission gauge No. 75.
4606	606	101.70	103.00	−1.30	....	....	96.90	4.80	Bedford.

Statement of material in levees in Upper Tensas levee district May 1, 1904.

Red Fork Extension levee, in place May 1, 1903		1,111,285
Costello Gin to Louisiana State Line, in place May 1, 1903		13,113,655
Louisiana State Line to end of district, in place May 1, 1903		14,867,928
Total in place May 1, 1903		29,092,868

MATERIAL ADDED.

Main line of levee in Arkansas, United States contracts	371,593	
Leland Spur levee in Arkansas, United States contracts	51,653	
Contracts by local boards in Arkansas	317,237	
Main line of levee in Louisiana, United States contracts	253,844	
Contracts by State and Fifth Louisiana district in Louisiana	1,490,973	
		2,485,300
		31,578,168
Less yardage abandoned in Arkansas and Louisiana		794,042
Total material in levees May 1, 1904		30,784,126

Expenditures from May 1, 1903, to May 1, 1904, in Upper Tensas levee district.

Month.	Engineering.	Repairs.
1903.		
May	$789.86	....
June	752.75	....
July	923.01	$22.10
August	929.64	13.65
September	811.51	....
October	840.76	30.00
November	842.71	....
December	900.14	....
1904.		
January	814.60	....
February	1,022.83	573.21
March	973.62	2,431.24
April	1,019.80	1,511.94
Total	10,620.73	4,582.14

Distribution.

	Amount.	Per cent.
Engineering	$10,620.73	7.81
Repairs	4,582.14	3.37
Expense of steamboats on high-water service and surveys	2,142.59	1.58
Construction	118,697.04	87.24
	136,042.50	100
Expended by local boards	460,857.59	
Grand total	596,900.09	

Of the above $460,857.59 furnished by the local boards, $102,197.10 was expended in Arkansas under the supervision of the United States engineers, for which credit should be taken, and which would reduce the percentage for engineering expenses from 7.81 to 4.46.

APPENDIX 2 O.

REPORT OF MR. CHAS. LE VASSEUR, U. S. ASSISTANT ENGINEER, ON SURVEYS IN FIRST AND SECOND DISTRICTS DURING SEASON OF 1903-4.

MEMPHIS, TENN., *May 1, 1904.*

CAPTAIN: I have the honor to submit the following report on surveys in first and second districts during the season of 1903-4:

These operations comprise the general hydrographic surveys of the principal improved reaches, local detailed surveys over revetment works, hydrographic surveys of different parts of the river where caving of the bank was active, special surveys of localities where work was projected or changes in the river had occurred, and general and detailed surveys in the different levee districts, together with the 1904 high-water elevations along the levees.

In addition to these surveys, in the different levee districts the survey work necessary for and during construction was performed by the levee inspectors, independently of the regular survey party, and are therefore not reported here.

The following list shows in detail the location and kind of surveys made:

General surveys of reaches.

Caruthersville, Mo. (110-113), 3 miles.
Plum Point reach (150-170), 20 miles.
Memphis reach (219-223), 14 miles.
Helena reach (303-312), 9 miles.

Hydrographic detailed surveys.

Daniels Point, Ark. (152 R.).
Ashport Bend, Tenn. (155 L.).
Fletchers Bend, Ark. (159 R.).
Osceola bar, Ark. (165 R.).
Hopefield Bend, Ark. (228 R.).
Memphis bar, Tenn. (230 L.).
Helena, Ark. (307 R.).
Hathaway Dikes, Mo. (100 R.).

Caving banks.

Birds Point, Mo. (0 R.).
Wickliffe, Ky. (4 L.).
Hickman, Ky., to Slough Landing, Tenn. (36 to 59 L.).
Point Pleasant, Mo. (76 to 83 R.).
Gayoso, Mo., to Island No. 16 (105 R. to 115 R.).
State Line, Mo. and Ark. (128 R.).
Redman Point, Ark. (220 R.).

Special surveys.

Caruthersville, Mo. (109–115 R.).
River Styx, Ark. (140 R.).
Pecan Point-Golden Lake, Ark. (194–197 R.).
Drainage of pits, Eagle Lake, Ark., on M. 130, Lower St. Francis levee district (210 R.).
Hollybush 1903 breaks, Bradley to Redman Point (215–220 R.).
Head of Hopefield Bend, Ark. (227 R.).
Commerce-Peters Landing, Ark. (270 R.).
Island No. 63, Miss. (333 L.).

Levee surveys.

Upper St. Francis district: Location of new levee and general topographical survey from 5 R. to 32 R.

Flood elevations, year 1904, along the levees, Upper St. Francis.

Reelfoot district: Location of new levees and general topography from 36 L. to 49 L. Flood elevations, 1904, along the levees.

Lower St. Francis district: Location of new levees and 1904 flood elevations along the whole line of this district.

Maps of the above-mentioned surveys have been prepared and sent to the Memphis office.

As all the changes in the reaches and the results of the survey-party work are shown by the maps just prepared for the annual report, no special description of them will be given in this report.

The survey party has been delayed a great deal in its operations during the past season for lack of proper accommodations for quarters and for taking soundings. No quarterboats, tent, or camping outfit being available for a time, the party had to find board and lodging wherever possible. Most of the time accommodation could only be found several miles away from the site of the work, forcing the party to short hours in the field and rendering impossible the plotting of notes at night. When quarterboat *No. 39* was placed in commission, the party was delayed sometimes a whole week waiting for a steamboat to move the quarterboat from one survey to another.

All the soundings for the past season were taken with the use of a skiff, rendering necessary a double crew of oarsmen and leadsmen. The work could not be prosecuted with rapidity, as the swiftness of the current at many places rendered skiff operations nearly impracticable.

I respectfully suggest that for next year's operations proper quarters be furnished to the party and that the United States tender *H. L. Abbot* be placed in commission for the use of the survey party, or that a gasoline launch be bought for the exclusive use of the party.

Heretofore the United States tender *Abbot* and quarterboat *No. 39* belonged exclusively to the survey-party outfit; with such accommodations the work was prosecuted rapidly and the maps were kept to date on the boat, with field work every night, which is quite an advantage.

I will respectfully recommend also that all the detailed survey-station lines in the different reaches be resurveyed and restaked with permanent hubs.

Iron hubs were placed by me in 1894 when I established all the detailed survey lines. These hubs were tied to all the triangulation points, and thus easy and accurate comparisons of different surveys could be made, as they were each referring to the same stations. These hubs are now either destroyed or covered by sediment. Their disappearance affects the accuracy of the surveys as far as comparison is concerned, new stations being established at each survey not coinciding with the old hubs and in many places not tied on triangulation points.

Respectfully submitted.

CHAS. LE VASSEUR,
Assistant Engineer.

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

APPENDIX 2 P.

REPORT OF MR. LUTHER Y. KERR, JUNIOR ENGINEER, ON SURVEYS IN THIRD DISTRICT DURING SEASON OF 1903–4.

MEMPHIS, TENN., *May 1, 1904.*

CAPTAIN: I have the honor to submit the following report of surveys made under my charge in the third district, Mississippi River improvement, from May 1, 1903, to May 1, 1904:

During the low-water season the following surveys and examinations were made:

The annual hydrographic surveys over the revetment at Lake Bolivar front (417 L.), Ashbrook Neck (446 L.), Greenville Harbor (478 L.), Lake Providence (540 R.), and Delta Point (598 R.).

Special hydrographic surveys in the vicinity of the La Grange crevasse (482–485 L.), in Kentucky Bend (498–502), at Lake Providence (540–541), at Hollybrook crevasse (545–549), and from Youngs Point to Klienston (595–599).

Shore-line surveys along the upper side of Caulks Neck (408–411), Carters Neck (460–463 L.), Leland Neck (469–472 R.), at Island 92 (527–529 L.), Atherton (557–558 R.), Willow Point (563–566 R.), and in Reed-Bedford Bend (603–608 R.).

Before giving the results of the above, it might be well to give in some detail the methods employed in the field to obtain them.

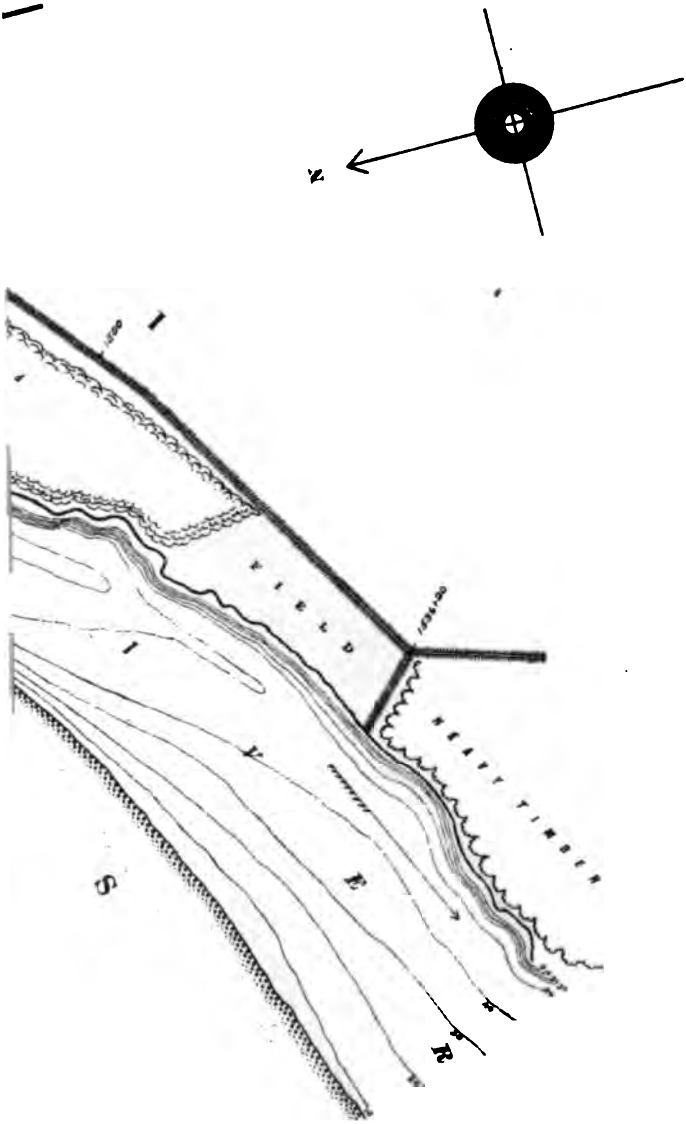
By referring to any of the revetment maps furnished for your annual report, you will notice that throughout the extent of each revetment there is a base line conveniently located. These base lines, from which all mattresses are accurately located before being sunk, were originally laid out before the revetment works were begun, connected with points of the Coast and Geodetic Survey or with the Commission stone lines, and extended as necessary to precede the progress of the bank improvement. They are fixed by having the angle points marked with a spike driven in a heavy oak hub, usually 6 by 6 inches by 3½ feet, securely set in the ground.

The ranges upon which the soundings are taken are located at regular intervals, from 100 to 200 feet, along the base line and normal to it, the shore end being a point or station in the base line marked by a sawed stake, from which all lateral distances on the respective ranges are reckoned. When a survey is to be made over a revetment the base line is first retraced and the station stakes marking the ranges are replaced where missing, relined, and recentered. Perpendiculars are turned off from each station stake, and one or more temporary stakes put in to mark the range. Transit or observation points are located with reference to the base line. Where the configuration of the shore line will permit, these points are placed near the ends of the tangents, either on the base line or at a known distance to the front. Angles on soundings are measured from the base line or a line parallel to it, and in such cases the distances are taken off on a coordinate protractor and corrected for the position of the instrument in case it is not on the base line. If the transit point is beyond the tangent normal to the ranges, the angles are plotted and the distances scaled off from the original base line.

The soundings are taken with a 15 or 20 pound lead, depending upon the depth of water and velocity of current, on a five-eighths inch 3-ply cotton line graduated in feet, from the deck of a small steamer which takes a position on the outer end of the section and flanks toward shore, keeping the forward end of the boat always on the range. The lead is manipulated so as to get a perpendicular measurement, or the actual depth, as near as possible. In deep water, in order to do this, the lead is taken to the bow by the lead bearer and cast as far forward as possible; the leadsman stands well down the guard, say 30 or 40 feet from the bow (depending on the depth expected), plays the line out as necessary until it comes to a vertical position, when the lead should be very near the bottom. He then moves down the guard with the current, playing the line out vertically until the lead strikes the bottom, when the slack of the line is jerked out, the soundings read by the leadsman and checked by the recorder.

It will be seen from the above that it is a simple matter, with a steamer 90 to 100 feet in length, to give the lead a lead of 70 feet, and assuming that it would descend at the rate of 12 feet per second it would reach a depth of 105 feet in a current having a mean velocity of 8 feet per second by the time the line reached a perpendicular position. I am of the opinion that in these extreme cases where the soundings are taken in this manner the probable error will not exceed 1 per cent.

The lead line is tested twice a day by a standard laid off on the boat's guard, the errors noted and the soundings corrected accordingly.



NOTE Soundings reduced to 89 feet Memphis Datum,
Corresponding to Zero of Greenville Gage.
River practically stationary.

March of this year the caving had extended back from 200 to 300 feet farther, leaving a maximum distance from shore to levee of 590 feet. This rate of caving will necessitate a new loop this season.

Willow Point (*563–566 R.*).—Caving continues in the bend and is working downstream, the greatest caving being below Salem Landing. The old front levee will probably last eighteen months or two years. This, however, is backed up by the Willow Point Loop, which is still about 3,000 feet from the shore end at the lower end, where it will be first attacked.

Reed-Bedford Bend (*603–606 R.*).—The maximum caving in this bend has been about 1,200 feet in the past four years along the Reed front. Along the lower part of the bend it amounted to from 300 to 1,000 feet. All the levee in this bend will probably have to be abandoned within the next four years.

All of the above surveys have been plotted, and the following maps are furnished for your annual report:

Maps showing special surveys of Kentucky Bend, Hollybrook, Delta Reach, and a part of Lake Providence reach.

Maps showing the effective revetment at Lake Bolivar front, Ashbrook Neck, Greenville Harbor, Lake Providence, and Delta Point.

Respectfully submitted.

LUTHER Y. KERR,
Junior Engineer.

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

APPENDIX 2 Q.

PRELIMINARY EXAMINATION OF MISSISSIPPI RIVER IN FRONT OF WICKLIFFE, KENTUCKY.

[Printed in House Doc. No. 226, Fifty-eighth Congress, second session.]

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, December 10, 1903.

SIR: The river and harbor act of June 13, 1902, provides for a preliminary examination of the Mississippi River in front of Wickliffe, Ky., with a view to ascertaining what improvement is necessary to preserve the harbor and facilitate navigation, such examination to be made by the Mississippi River Commission.

I have the honor to submit herewith a report, dated October 25, 1902, by Capt. E. E. Winslow, Corps of Engineers, on a preliminary examination of the locality in pursuance of the said provision of law and forwarded to this office by Col. Amos Stickney, Corps of Engineers, president Mississippi River Commission, with letter of November 21, 1902. In the opinion of Captain Winslow, which is concurred in by Colonel Stickney, the improvement of this locality for the purpose stated in the act is not worthy of being undertaken by the General Government.

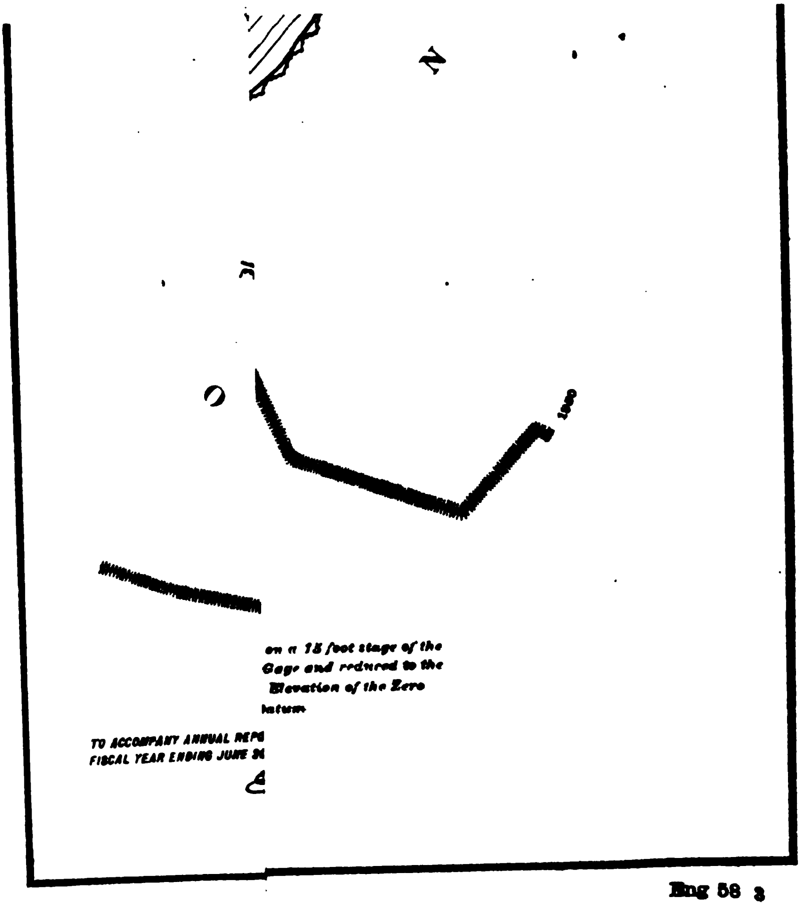
This report has been reviewed by the Board of Engineers for Rivers and Harbors, under the provisions of sections 3 and 14 of the above-mentioned act, and, for reasons stated in its report of March 17, 1903, the Board concludes that no improvement is necessary to preserve the harbor and facilitate navigation, and that it is not desirable for the United States to undertake this work.

I concur in the views of the Board.

Very respectfully, your obedient servant,

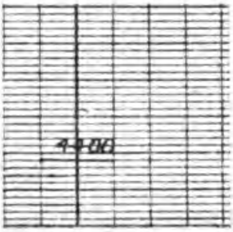
G. L. GILLESPIE,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.


1880
on a 15 foot stage of the
Gage and reduced to the
Elevation of the Zero
Datum
TO ACCOMPANY ANNUAL REPO
FISCAL YEAR ENDING JUNE 30

Eng 58 3

MAP
of
KENTUCKY BEND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REPORT OF COL. AMOS STICKNEY, CORPS OF ENGINEERS.

MISSISSIPPI RIVER COMMISSION,
St. Louis, Mo., November 21, 1902.

GENERAL: The Mississippi River Commission submits the following report, in obedience to the directions contained in section 14 of the act of Congress approved June 13, 1902, as advised by the Chief of Engineers in letter of June 23, 1902:

The general situation in front of Wickliffe, Ky., has been familiar to the Commission for many years; but for the sake of exact and recent information the Commission has caused a preliminary examination to be made of the locality by Capt. E. Eveleth Winslow, Corps of Engineers, district officer in charge of the first and second districts, Mississippi River, below Cairo, and transmits herewith his report and map[a] accompanying the same.

Since the date of said report and during its present trip of inspection the Commission personally inspected and examined the bank in front of Wickliffe and the conditions there existing, and is of opinion that the only improvement possible in the Mississippi River at that point is an extended and costly bank revetment; that such improvement is not required in the interest of navigation; that as respects the preservation of the bank for a harbor the cost of the improvement would be out of proportion to the interests to be protected, and hence, that as a means for preserving the harbor and facilitating navigation the proposed improvement is not worthy to be undertaken by the Government.

This examination has been made without expense to the United States.

Very respectfully, your obedient servant,

AMOS STICKNY,
Colonel of Engineers,
President Mississippi River Commission.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS, U. S. ARMY,
December 5, 1902.

Respectfully referred to the Board of Engineers for Rivers and Harbors, constituted by Special Orders, No. 24, Headquarters, Corps of Engineers, current series, for consideration and recommendation, as required by section 3 of the act of June 13, 1902.

By command of Brig. Gen. Gillespie:

A. MACKENZIE,
Colonel, Corps of Engineers.

[Second indorsement.]

BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
Washington, D. C., March 17, 1903.

Respectfully returned to the Chief of Engineers, United States Army.

The Board of Engineers for Rivers and Harbors has considered the within report of the Mississippi River Commission and that of the district officer.

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[a] Not printed.

The local commerce involved is insignificant, being given as 3,000 tons per annum.

The principal interests concerned are those of two railroads, whose rights of way are endangered by the cutting of the river bank.

In the opinion of the Board the work desired, which is simply bank protection, would be of little benefit to local commerce and of no benefit whatever to through navigation. It would be very costly and would serve only to protect the rights of way of two railroads and certain other private property.

The Board therefore believes that no improvement is necessary to "preserve the harbor and facilitate navigation," and that it is not desirable for the United States to undertake this improvement.

For the Board:

H. F. HODGES,
Major, Corps of Engineers,
Senior Member Present.

REPORT OF CAPT. E. EVELETH WINSLOW, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., October 25, 1902.

COLONEL: In compliance with your indorsement of June 30, 1902, I have the honor to submit my report upon the preliminary examination of the Mississippi River in front of Wickliffe, Ky., made in pursuance of the act of Congress approved June 13, 1902, which directs that a "preliminary examination" shall be made at the following locality:

> Mississippi River in front of Wickliffe, Ky., with a view to ascertaining what improvement is necessary to preserve the harbor and facilitate navigation; such examination to be made by the Mississippi River Commission.

Wickliffe is situated on the left bank of the Mississippi River a short distance below the mouth of the Ohio River. At this point the bank of the river is quite close to the bluff which forms the eastern border of its alluvial bottom. The city is built at the foot of the bluff and on the bottom of a wide ravine in the bluff; the city itself is above the reach of floods, but the land between it and the river is subject to overflow, at extreme high water, to a depth of 12 feet or more. Between the bluff and the river are located the main line tracks of two important railroads, the Illinois Central and the Mobile and Ohio, these tracks being laid, owing to danger from floods, on high embankments or trestles. Each of these railroads has a station at Wickliffe, and on the river bank opposite the city is Wickliffe Landing. This landing is used by the regular river packets and also by a ferryboat. The packets stop whenever their business requires it, and the ferryboat makes several round trips each day between Wickliffe, Ky., Bird Point, Mo., and Cairo, Ill. The county road leading from the city to the landing is in the bottom and can not be used when the river gets out of its banks, although where the road crosses Willow Creek there has been constructed a highway bridge which has its floor above high water and is approached by inclines at either end.

The following statistics with reference to the business interests of the city have been furnished me by the mayor:

There are at present residing in the city something less than 2,000 people. Its assessed valuation for the purpose of taxation is $425,000; the capital invested in manufacturing and business interests amounts to about $350,000, of which about one-third is invested in tobacco factories. It is estimated that about 3,000 tons of freight are landed annually at Wickliffe Landing, while about 500 tons are transported in wagons by the ferry.

The bank of the river in the vicinity of Wickliffe has been caving steadily for a number of years, this caving being due to the almost direct impingement of the currents from the Ohio and upper Mississippi rivers. On the accompanying map are shown the bank line determined from a recent survey and the one taken from the survey of 1877. A comparison of the bank lines given by these two surveys shows that in these twenty-five years the bank in front of the town has receded by about 1,000 feet, while above and below the town the recession has been not quite so much. The caving at present begins about 4,000 feet above the town and extends downstream to about a mile below the landing. The bank at present is caving most rapidly a short distance below the town, and at this point the bank has receded nearly 250 feet in the last three years.

It is probable that the bank in this bend of the river will continue to cave for years to come unless it is prevented by artificial means. At what rate the bank will recede and at what point this caving will be a maximum, it is of course impossible to predict, but judging from the shape of the rivers above and the changes that are taking place in them it is probable that the head of the caving in Wickliffe bend and the point of maximum attack will continue to move downstream, as they have done in recent years. The bank of the river at the landing is now about 1,000 feet from the railroad embankment and station, and if the conditions of caving should continue as at present, it would be some twelve or fifteen years before the bank in front of the city has receded as far as the railroad, and if in these years the caving should move downstream, as appears probable, the bank recession in front of the city will probably not reach the railroad station. There does not seem to be any reason why the rate of caving should increase, and consequently the city itself is, in my opinion, not so threatened by the caving bank as to make its protection a subject for consideration now or in the near future. The land that is being destroyed by the caving is of no greater value than the other alluvial bottom land, and is therefore no more worthy of protection than the banks along many miles of the river.

The only improvement possible here, and the one desired by the residents of the town, is the revetment of the bank, which would prevent its further recession. This work would involve no feature not met with at other points of the river where the bank has been revetted, and it could be successfully done with the usual standard revetment, consisting of a fascine subaqueous mat about 250 feet wide and a paving of stone for the upper bank. The cost of this work, if it should be done with the regular Mississippi River Commission's plant, would probably be about $27 per linear foot of bank. Such a revetment, to be of any value, must be continuous, and unless it is expected to constantly repair its head it should begin at about the head of the caving, though if the work is to be done a little at a time and to be followed certainly by work in subsequent years, it might be well to place the first year's work at or just above the point of maximum caving. Such a piece of work, however, would be subject at its extremities to severe attack, and to prevent its destruction it must be extended upstream within a year or two after its construction. It is believed that it would not be economical to do less than 2,000 feet of work per season.

The act directs that this improvement should be considered with reference to the preservation of the "harbor." The only harbor here is the landing and its improvements, these improvements consisting of two warehouses and a ramp cut down the bank to near the low-water line. The warehouses are small and are so built as to be easily movable. The ramp consists of a simple road cut into the steep bank and is necessary for the use of teams getting on and off the ferryboat. Of course, as the bank caves away the warehouses have to be moved back from time to time, and the ramp must be dug over again as fast as it is destroyed by caving. Fortunately, at high stages the ramp that is needed is short and at low stages the caving is not rapid, and consequently the cost of maintaining this ramp can not be very great. During overflow stages the landing can not be used at all, and the ferryboat runs up the creek or over the fields themselves, if the overflow be deep enough, up to the railroad embankment, which is then utilized as a landing. If the bank was revetted the cost of moving the warehouses and of recutting the ramp would be avoided, but with the rapidity of the present caving Wickliffe is much better off than many of the landings on other parts of the river, and the saving that would be made in avoiding these two sources of expense is not worthy of consideration in comparison with the cost of the revetment.

The act further directs that the improvement should be considered with reference to its effect on "navigation." The channel of the river along this bend is of ample depth and width, and no improvement to its navigability is now required. At the foot of this bend the navigable channel crosses from near the Kentucky shore at Fort Jefferson over to Norfolk Landing on the Missouri shore. This crossing would probably be somewhat improved by the revetment of the banks of Wickliffe bend, but as this crossing has not in recent years given any trouble and as its channel seems to be maintained with a greater available depth than is found on the crossings above and below, its improvement would not appreciably affect the navigability of the Mississippi River.

Consequently, it is my opinion that as far as the protection of the city of Wickliffe is concerned and for the purposes stated in the act, namely, "to preserve the harbor and facilitate navigation," this improvement is not worthy of being undertaken by the Government.

There is, however, one feature connected with the commerce of the country, and that is affected by this caving bank to such an extent that I think it proper to call it to the attention of the Commission. From Wickliffe downstream for some 6,000 feet the Illinois Central Railroad is constructed at the foot of the bluff and as close to the bluff as it can safely be placed in view of possible landslides. Outside of this railroad is located the track of the Mobile and Ohio Railroad, and at one point about a mile below Wickliffe the bank has receded until it is so close to the railroad at present that if the bank were revetted this year the graded slope of the upper bank would about reach the toe of the railroad embankment. It is, therefore, certain that unless something be done at an early date the railroad embankment at this place will cave into the river. This will necessitate the removal of the track and its reconstruction upon an embankment farther from the bank. The two railroad tracks at this point are about 300 feet apart, and the Mobile and Ohio track can therefore be moved back that distance, but as this will place both tracks at the foot of the bluff it is evident that they can not be moved back farther, and even this change in location of the tracks merely delays and does not solve the problem.

It is certain that the caving will continue and in some four or five years will again reach and threaten the railroad embankment, and if the caving be not then checked both embankments will be destroyed and an entirely new location must be selected for the railroads, for it is manifestly impossible to maintain them on the exposed face of a caving bluff. The top of this bluff is about 200 feet above low water, or about 150 feet above the present grade of the railroad track, and to change the location of the railroad to the top of this bluff would require the construction of a new line beginning some 3 or 4 miles above Wickliffe and joining the present lines of the railroads several miles below. Such a change in location would be very expensive, indeed, and it would appear, therefore, that the revetment of this bank at an early date is of vital importance to these railroads; and there should, therefore, be constructed in the next year or two some 4,000 feet of revetment, and this must from time to time in the future be extended or repaired at its head as the occasion may require.

As the consideration of this improvement for this purpose is not included in the purposes named in the act, I do not consider it proper to submit a recommendation as to whether this work is worthy of being undertaken by the Government or should be left to the railroad companies.

Very respectfully,

E. EVELETH WINSLOW,
Captain of Engineers.

Col. AMOS STICKNEY,
Corps of Engineers, U. S. A.,
President Mississippi River Commission.

APPENDIX 3.

REPORT OF CAPT. CHAS. S. BROMWELL, CORPS OF ENGINEERS, ON OPERATIONS IN THE FOURTH DISTRICT.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 1, 1904.

COLONEL: I have the honor to submit the following report upon the work of the fourth district, Mississippi River improvement, for the period from June 1, 1903, to June 1, 1904:

The fourth district extends from Warrenton, 7½ miles below Vicksburg, to the Head of the Passes, about 13 miles from the Gulf of Mexico, a distance of 452.8 miles by river.

The works include the improvement of the harbors at Natchez, Miss., and Vidalia, La.; improvements at the junction of the Mississippi, Red, and Atchafalaya rivers; improvement of the harbor of New Orleans, La.; bank protection in Bondurant Chute; bank protection in Kempe Bend, and the construction, repair, and maintenance of the levee system of the district.

This work was in charge of Capt. Chas. S. Bromwell, Corps of Engineers, until May 27, 1904, and since that date in charge of Lieut. Col. H. M. Adams, Corps of Engineers.

HARBORS OF NATCHEZ AND VIDALIA.

The project for this work, adopted June 29, 1891, contemplates the construction of a levee on or near the axis of Cowpen Neck, to prevent the flow of water across the neck during high stages of the river, and the construction of about 16,000 linear feet of bank revetment in Giles Bend. Estimated cost, $541,300.

The object of the proposed work is to prevent the formation of a threatened cut-off at Cowpen Neck, which would cause the destruction of the town of Vidalia, much injury to the water front of Natchez, and the probable destruction of parts of the levee system, due to increased caving of the banks above and below.

At the beginning of the fiscal year there was in place about 14,674 linear feet of revetment of various kinds, measured parallel to the general shore line, and the work was generally in good condition.

The work proposed for the past season merely contemplated the repair of existing works.

Operations were begun at this place January 23, 1904, and were carried on in connection with other works in the locality until March 26, 1904, when work was suspended.

As a result of this season's work the revetment at the lower end of the bend has been made continuous by closing the gap, 115 feet in length, left open to allow a salient point to wear back to the general line of the revetment, and remattressing a cave about 300 feet long, which occurred immediately below. The present length of the revetment in the lower end of the bend is now 6,664 feet, measured parallel to the general shore line.

In the upper bend minor repairs were made to spurs Nos. 1, 12, and 13, and the revetment here is now 7,807 feet long, measured parallel to the general shore line.

In the pocket between the upper and lower revetments, where the 300-foot square mattress was sunk last season, no work was done, but the timber standing near the edge of the unprotected bank that was likely to cave in and obstruct future work was felled.

During the year 127,560 square feet of mats were constructed and towed from Warrenton bar above and placed in the revetment at a cost of $0.06775 per square foot. The work being in the nature of repairs, the cost per linear foot is not a practicable unit.

The annual survey of Giles Bend, completed in November, 1903, shows that the existing work is generally in good condition, but that there has been marked scour in the upper end of the bend and considerable recession of the bank line over the unprotected portion, especially immediately above Spur No. 1.

During low water an examination of the harbor front of Natchez was made and it was ascertained that there had been considerable caving of the upper bank. Plans for the protection of the harbor front are under consideration and will be submitted when funds for the work are appropriated.

The caving at the ends of the completed revetment in Giles Bend has continued, and it is feared that some work will be destroyed before the revetment can be extended.

The details of this work and its cost are set forth in the appended report of my assistant, Mr. H. S. Douglas. Sketches are herewith, showing the location of the work done and the rate of caving of the bank.

The amount expended from June 30, 1903, to June 30, 1904, is $11,349.64, distributed as follows:

Office expenses, main office		$1,220.87
Other administrative expenses		728.44
Construction of revetment (hired labor):		
Materials	$1,753.15	
Wages	3,239.02	
Subsistence	942.57	
		5,934.74
Manufacture of concrete ballast		1,082.71
Surveys		1,214.77
Repairs to plant		622.84
Care of plant		231.75
New plant		313.52
		11,349.64

Money statement.

ALLOTMENT FOR HARBORS AT NATCHEZ AND VIDALIA, MISSISSIPPI AND LOUISIANA.

Amount allotted from appropriation for maintenance of river and harbor improvement, act of June 13, 1902		$12,000.00
June 30, 1904, amount expended during fiscal year, for maintenance of improvement		11,349.64
July 1, 1904, balance unexpended		650.36
July 1, 1904, outstanding liabilities		129.19
July 1, 1904, balance available		521.17
Amount that can be profitably expended in fiscal year ending June 30, 1906, in addition to the balance unexpended July 1, 1904:		
For works of improvement	$150,000.00	
For maintenance of improvement	10,000.00	
		160,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1889.		

IMPROVING ATCHAFALAYA AND RED RIVERS, LOUISIANA.

The present project, adopted October 3, 1890, is to secure and maintain navigable connections at all stages of the water between the Red and Mississippi rivers and between the Mississippi and Atchafalaya rivers; to prevent the enlargement of the Atchafalaya River, and to secure and maintain, by dredging through lower Old River, a navigable channel between the Mississippi and Atchafalaya rivers, 75 feet wide at the bottom and having a depth of 5 feet below the zero of Barbres gauge.

On account of lack of funds the first feature of the approved project has been definitely abandoned, narrowing the project to preventing the enlargement of the Atchafalaya River and maintaining a navigable channel through lower Old River.

That portion of the project relating to the preventing the enlargement of the Atchafalaya River was completed last year, and nothing further is contemplated unless such work as may be required for the maintenance of the existing sill dams. The condition of Sill Dams Nos. 1 and 3 is good, except that the shore end of the apron mattress at Dam No. 3 requires slight repairs.

During January, 1904, parties interested in the navigation of Old River complained of shoal water through the channel. The hydraulic dredge, *The Ram*, belonging to the work, was ordered there. By the time that she arrived the river had commenced to rise and no dredging was necessary.

The dredging plant has been repaired and all working parts placed in good condition.

A careful survey of lower Old River from the Mississippi to the head of the Atchafalaya, has been made. The results indicate but slight changes in the average cross section from 1894 to date. In a general way the changes are in a direction of an increase in depth and a decrease in width, both of which are favorable for the maintenance of the low-water channel.

Additional details of the work will be found in the accompanying report of my assistant, Mr. H. S. Douglas.

The amount expended from June 30, 1903, to June 30, 1904, is $2,461.58, distributed as follows:

Office expenses, main office		$135.47
Other administrative expenses		26.40
Dredging in Old River:		
Materials	$21.00	
Wages	290.35	
Subsistence	76.34	
		387.69
Repairs to plant		1,030.67
Care of plant		462.15
New plant		339.55
Miscellaneous		79.65
		2,461.58

Money statement.

ALLOTMENT FOR ATCHAFALAYA AND RED RIVERS, LOUISIANA.

July 1, 1903, balance unexpended	$4,470.44
June 30, 1904, amount expended during fiscal year, for maintenance of improvement	2,461.58
July 1, 1904, balance unexpended	2,008.86
July 1, 1904, outstanding liabilities	61.88
July 1, 1904, balance available	1,946.98
Amount that can be profitably expended in fiscal year ending June 30, 1906, for maintenance of improvement, in addition to the balance unexpended July 1, 1904	10,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

NEW ORLEANS HARBOR.

The project for this locality contemplates the protection of all caving banks in the harbor. Where the slope of the subaqueous bank is moderate the protection is afforded by spur dikes placed at suitable intervals; where the slope of the subaqueous bank is excessive the protection is afforded by continuous revetment placed outside of the 60-foot contour, the steep bank inside of that limit being cut down either by natural or by artificial means until the slope becomes moderate, when the continuous revetment will be laid inside the 60-foot contour.

The project approved July 19, 1902, and under which the work of the past two seasons has been carried on, provided for extending the continuous revetment 1,800 feet above Southport and 4,750 feet below. Of this, 715 feet was placed last year, and under the project approved July 23, 1902, the original length of the proposed work was reduced by 600 feet.

The work proposed for the season was to complete the revetment under the modified project, and this has been done so far as the funds available would permit.

Mattress construction for work in New Orleans Harbor was begun at Fancy Point, above Port Hickey, in August, 1903, and the first tow of mats was brought down near the end of the same month. The last mat was sunk in place in December, the whole work extending over a period of 141 days, during which time 1,200,000 square feet of willow mattress were constructed, towed about 175 miles, and sunk, at a cost of $0.0625 per square foot.

The revetment above Southport has been completed and it has been extended 3,770 feet below. In all, 4,750 linear feet of bank has been revetted, at a cost of $18.40 per linear foot.

The annual survey made at Southport, Gouldsboro, Algiers Point, and over the Third district reach shows that existing works are in good condition, and it is not thought that the present high water has occasioned any serious damage.

During the forthcoming season no work is contemplated in New Orleans Harbor, as no funds have been appropriated or allotted.

The conditions in New Orleans Harbor are described in Major Derby's report for 1902, and I concur in the conclusions therein stated. More liberal appropriations should be made for this locality, as has been recommended by myself and my predecessors.

Further details of the work and its cost will be found in the appended report of my assistant, Mr. H. S. Douglas. Sketches are also herewith, showing the location of the work done at or near Southport.

The amount expended from June 30, 1903, to June 30, 1904, is $66,448.08, distributed as follows:

Office expenses, main office		$2,259.53
Other administrative expenses		3,227.26
Construction of revetment (hired labor):		
Materials	$4,533.54	
Wages	38,540.10	
Subsistence	11,639.91	
		54,713.55

Surveys	$988.06
Repairs to plant	1,048.08
Care of plant	1,707.37
New plant	2,425.40
Miscellaneous	78.83
	66,448.08

Money statement.

ALLOTMENT FOR NEW ORLEANS HARBOR, LA.

July 1,1903, balance unexpended	$72,612.41
June 30, 1904, amount expended during fiscal year, for works of improvement	66,448.08
July 1, 1904, balance unexpended	6,164.33
July 1, 1904, outstanding liabilities	955.94
July 1, 1904, balance available	5,208.39
Amount that can be profitably expended in fiscal year ending June 30, 1906, in addition to the balance unexpended July 1, 1904, for works of improvement	300,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

BONDURANT CHUTE REVETMENT.

The project for this work, adopted June 20, 1899, contemplates the construction of a continuous revetment for a length of 1,600 feet for the protection of the levee line in that vicinity.

At the beginning of the fiscal year 2,107 linear feet of revetment were in place, and it was generally in good condition.

The work proposed for the past season was to extend the revetment about 200 feet farther downstream and to mattress the upper bank for a distance of 150 feet, where high-water scour had occurred.

Mattress construction for Bondurant revetment was commenced and completed at Warrenton bar during December, 1903, but it was not until March, 1904, that the river rose to a height sufficient to admit the sinking plant into the chute. The mats were all sunk and projected work completed by March 25, 1904.

During the year 55,000 square feet of mats were constructed, towed from Warrenton bar, and placed in the revetment at a cost of $0.069 per square foot. The revetment was prolonged 188 feet with mattresses 200 feet wide, and the upper bank, at a salient point between the work of 1900–1901 and 1902–3, covered for a distance of 150 linear feet with a mat 100 feet in width. The average cost of the revetment constructed was $14.80 per linear foot.

It is believed that one effect of the revetment has been to cause a fill at and near the head of the chute. To determine this definitely a survey of the bank line, from the head of the chute to below the revetment, has been made, and three cross sections of the chute near the head located and sounded to form the basis for future comparative surveys.

It is believed that the revetment as it now stands, with a length of 2,295 linear feet measured parallel to the general shore line, is a complete work, and that nothing further will be required at this locality next year beyond current repairs.

The details of this work and its cost are set forth in the appended report of my assistant, Mr. H. S. Douglas, and sketches are herewith showing the location of the work done and rate of caving of the bank.

The amount expended from June 30, 1903, to June 30, 1904, is $5,000, distributed as follows:

Office expenses, main office		$558.98
Other administrative expenses		391.74
Construction of revetment (hired labor):		
Materials	$877.58	
Wages	1,964.24	
Subsistence	143.55	
		2,985.37

Manufacture of concrete ballast	$411.22
Surveys	132.00
Repairs to plant	208.09
Care of plant	182.32
New plant	130.28
	5,000.00

Money statement.

ALLOTMENT FOR BONDURANT CHUTE.

Amount allotted from appropriation for maintenance of river and harbor improvement, act of June 13, 1902	$5,000.00
June 30, 1904, amount expended during fiscal year, for works of improvement	5,000.00

Amount that can be profitably expended in fiscal year ending June 30, 1906, for maintenance of improvement, in addition to the balance unexpended July 1, 1904	2,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

KEMPE BEND REVETMENT.

The project for this work, approved May 1, 1899, contemplates the construction of a continuous revetment of the bank for such a distance as may be necessary for the protection of the levee in the vicinity.

At the beginning of the fiscal year there was in place about 6,330 linear feet of revetment measured parallel to the general shore line, and the work was apparently in good condition.

The work proposed for the past season was as follows: To extend the revetment about 300 feet downstream, to extend it about 1,700 feet upstream, and to make such repairs to existing revetment as might be necessary.

Owing to extraordinary and unforeseen conditions it became impracticable to carry out this project literally. Upon the decline of the river in September a serious cave occurred in the old revetment placed in 1899–1900, which extended until about 2,670 linear feet had been partially or entirely destroyed. Rapid caving of the unprotected bank opposite the upper wing of the loop levee built in 1898–99 developed. As a result the work of the season has been to replace the mattress work where destroyed by caving, extending it up to about a half stage of the river, and to mattress the subaqueous bank opposite the threatened angle in the levee of 1898–99.

Work was begun at this locality September 19, 1903, by constructing the necessary mats at Warrenton bar below Vicksburg, and work on the revetment was prosecuted until February 27, 1904, when operations were suspended for the season.

As a net result of this season's work the revetment has been extended about 1,260 feet, making the total length of revetted bank in Kempe Bend 7,563 feet in three isolated pieces of 5,315, 1,395, and 883 feet in length, respectively, measured parallel to the general shore line.

During the year 1,080,265 square feet of mats were constructed and towed from Warrenton bar to Kempe Bend and placed in the revetment at a cost of $0.067 per square foot. Including the replacing of work destroyed by caving, 3,760 linear feet of revetment measured parallel to the general shore line was constructed at a gross cost of $23.60 per linear foot.

A survey of Kempe Bend, completed in November, 1903, shows a marked scour in the channel, especially opposite that portion of the revetment which failed. So far as is known at this time the condition of the work as restored is good. No injury to this revetment ever occurs until the river declines to a half stage or below.

Additional work will be necessary next year, but its extent and precise location can not be definitely determined, the point of attack by the river varying from year to year as the gravel bar above is shifted by the currents during high water. It is hoped to close the gap between the middle and lower revetments.

The character of the work done during the season at Kempe, Bondurant, and Giles Bend revetments has been essentially the same, and presents a favorable opportunity for analyzing the elements that go to make up the cost of this kind of work. This has been done with the following results:

Items.	Per cent of total cost.
Pay rolls (services of all kinds)	23
Subsistence (cooked and served)	08
Materials for construction (willows, ballast, etc.)	45
Steamers and tugs (towing, etc.)	13
Repairs to plant (emergency work)	03
New plant, such as wire cables, etc	03
New Orleans office (administration)	05
Total	100

It would appear from this table that improvement in the direction of reducing the cost of this character of bank revetment should be in the line of cheaper materials.

Details of the work in Kempe Bend and its cost are set forth in the appended report of my assistant, Mr. H. S. Douglas, and sketches are herewith showing the location of work done and the rate of caving of the bank.

The amount expended from June 30, 1903, to June 30, 1904, is $90,994.80, distributed as follows:

Office expenses, main office		$4,780.15
Other administrative expenses		3,860.98
Construction of revetment (hired labor):		
Materials	$15,802.43	
Wages	31,622.18	
Subsistence	12,275.27	
		59,699.88
Manufacture of concrete ballast		14,045.86
Surveys		937.22
Repairs to plant		2,218.16
Care of plant		2,606.30
New plant		2,584.20
Miscellaneous		262.05
		90,994.80

Money statement.

ALLOTMENT FOR KEMPE BEND REVETMENT.

Amount allotted from appropriation for maintenance of river and harbor improvement, act of June 13, 1902	$94,000.00
June 30, 1904, amount expended during fiscal year, for works of improvement	90,994.80
July 1, 1904, balance unexpended	3,005.20
July 1, 1904, outstanding liabilities	1,088.93
July 1, 1904, amount balance available	1,916.27
Amount that can be profitably expended in fiscal year ending June 30, 1906, for works of improvement, in addition to the balance unexpended July 1, 1904 Submitted in compliance with requirements of sundry civil act of June 4, 1897.	80,000.00

PLANT.

The plant of the district now consists of forty-eight large pieces, and has a capacity of about 7,500 linear feet of revetment. During the year several pieces have been condemned and sold, and five of the ten barges under contract last year have been delivered. Contract for four more barges has been entered into, and one of these has been delivered. A contract for the construction of a small steel hull stern-wheel steamer has been entered into, and fair progress on its construction has been made by the contractor.

During the year the necessary repairs to the plant have been made, and it is now, with a few exceptions, in good condition. A detailed statement of the work done for the care and maintenance of the plant is given in the appended report of my assistant, Mr. H. S. Douglas.

The amount expended from June 30, 1903, to June 30, 1904, is $52,784.09, distributed as follows:

Office expenses, main office		$691.20
Other administrative expenses		3,558.88
New plant		26,181.21
Repairs (hired labor):		
Materials	$6,603.15	
Wages	10,396.60	
Subsistence	1,273.45	
		18,273.20
Care of plant		4,073.85
Miscellaneous		5.75
		52,784.09

Money statement.

ALLOTMENT FOR PLANT.

July 1, 1903, balance unexpended	$45,370.50
Amount allotted from appropriation for maintenance of river and harbor improvement, act of June 13, 1902	47,000.00
Amount received from proceeds of sales of condemned engineer property	5,351.74
Amount received from owners of steamer *H. M. Carter* for injury to U. S. barge *No. 33*	18.00
	97,740.24
June 30, 1904, amount expended during fiscal year	52,784.09
July 1, 1904, balance unexpended	44,956.15
July 1, 1904, outstanding liabilities	1,834.37
July 1, 1904, balance available	43,121.78
July 1, 1904, amount covered by uncompleted contracts	42,800.00

SURVEYS, GAUGES, AND OBSERVATIONS.

During the year surveys were made at Giles Bend, Kempe Bend, Bondurant Chute, Old River, and in the Carrollton, Algiers, Gouldsboro, and Gretna bends of New Orleans Harbor, and in the third district reach of the same.

A survey for the location of a new line of levee was made in the Lower Tensas levee district from Greens (720.5-R) to Fairview (729-R), and the usual survey for bank lines were made in each levee district from time to time where necessary.

The gauge at Barbres Landing, at the junction of the Red and Atchafalaya rivers, has been maintained as heretofore.

The amount expended from June 30, 1903, to June 30, 1904, is $4,918.97, distributed as follows:

Office expenses, main office		$142.13
Other administrative expenses		104.88
Field work and drafting:		
Material	$66.50	
Wages	3,753.19	
Subsistence	434.60	
		4,254.29
Repairs to plant		100.96
Care of plant		43.02
New plant		168.69
Miscellaneous		105.00
		4,918.97

Money statement.

SURVEYS, FOURTH DISTRICT.

Amount allotted from appropriation for maintenance of river and harbor improvement, act of June 13, 1902	$6,000.00
June 30, 1904, amount expended during fiscal year	4,918.97
July 1, 1904, balance unexpended	1,081.03

LEVEES.

For work connected with levee construction and maintenance the district is subdivided into seven levee districts, as follows:

The Lower Tensas levee district, right bank, which extends from the upper limits of the fourth district, opposite Warrenton, Miss., to the mouth of Red River. In this district the levee system is continuous from the upper end of the district to Withlacooche (751 R), 144 miles by river, with the exception of a gap 6.72 miles in length extending from Bougere (738 R) to Union Point (743 R), which has not yet been leveed.

The Atchafalaya levee district, right bank, which extends from the mouth of Red River to the head of Bayou Lafourche, a distance of 122 miles by river. The levee system is continuous in this district.

The Lafourche levee district, right bank, which extends from the head of Bayou Lafourche to New Orleans, La. The distance by river is 78 miles, and the levee system is continuous.

The Barataria levee district, right bank, which extends from New Orleans, La., to the Head of the Passes, 82½ miles. The levee system is continuous down to the Jump, 71.5 miles.

The Homochitto levee district, left bank, created by a resolution of the Mississippi River Commission, November 19, 1894, which extends from the mouth of the Yazoo River to Baton Rouge, La., 238.5 miles by river. As yet there are no levees in this district, except a few detached lengths built by private parties.

The Pontchartrain levee district, left bank, which extends from Baton Rouge, La., to New Orleans, La., 123.5 miles. The levee system in this district is continuous.

The Lake Borgne levee district, left bank, which extends from New Orleans, La., to the Head of the Passes, 91 miles. The levee system at present only extends to the Salt Works, covering 75.66 miles of the river.

The funds available for levee construction in this district amounted to $379,951.95, being the unexpended balances from previous allotments, and $271,500 allotted for this purpose July 21, 1903.

The levee line has been improved this year by the United States to the extent of 1,270,806.88 cubic yards, at an average cost per cubic yard of 17.14 cents. The following table shows the variation in cost of levee building by the United States during the past fourteen years:

Years.	Cubic yardage.	Cost.	Years.	Cubic yardage.	Cost.
		Cents.			*Cents.*
1890	895,000	19.3	1897	1,773,000	10.99
1891	1,410,000	21.2	1898	3,392,000	14.12
1892	908,000	17.8	1899	2,465,000	13.60
1893	2,142,000	21.2	1900	2,735,000	13.23
1894	3,589,000	15.0	1901	232,000	14.26
1895	3,414,000	12.3	1902	1,316,918	14.40
1896	4,658,000	10.3	1903	1,270,807	17.14

The work has cost more this year than in preceding years, because heretofore the easiest and cheapest work has been completed and the work remaining is generally of a more difficult character. There has also been an increase in the cost of labor and supplies, making all levee work more expensive.

The following table shows approximately the present condition of the levee lines:

	Levee districts.					
	Lower Tensas.	Atchafalaya.	Lafourche.	Pontchartrain.	Barataria.	Lake Borgne.
Above high water of 1897:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Less than 1 foot			0.70	7.57	0.81	2.8
From 1 to 2 feet	1.23		10.41	25.20	21.64	15.2
From 2 to 3 feet	17.17	7.68	20.00	20.29	18.27	16.8
More than 3 feet	116.29	120.07	50.81	72.60	31.04	42.0
Totals	134.69	127.75	81.92	125.66	71.76	77.0

No work has been done in the Homochitto levee district, there having been no funds available.

The recent high water did not seriously threaten the levee system in this district. Beyond the usual inspection of the levees no protective measures were necessary.

From the excellent condition of the levee line of the Lower Tensas levee district, as shown by the above table, it would appear that not a very large amount of funds would be needed to bring the levee line in that district up to standard grade; but as great lengths of levee are now threatened by caving banks, large sums of money must be expended to maintain the levee line. The temporary lines of levee built within the last few years, as well as long lengths of levee adjoining these temporary levees, will fail at about the same time. The needs, therefore, of the other levee districts of the fourth district combined will be small when compared with those of the Lower Tensas district.

For the future location of levees at the lower ends of the two districts below New Orleans (the Barataria and the Lake Borgne), it would seem to be a wise policy to select locations based on a twenty-year existence rather than ten years, as has been the practice in the past, for the reasons that the rate of recession of the bank is very slow; the cost per linear foot of levee is one-third less in these districts than in the ones above New Orleans; and the tillable land below New Orleans consists of a narrow strip immediately adjoining the banks of the river, and its value per acre is three or four times as much as the land located on the Mississippi River above New Orleans.

The details of the work accomplished in the various levee districts are given in the following tables, and further discussed in the accompanying report of my assistant, Mr. W. E. Knobloch, superintendent of levees.

Fourth district levees, 1903-4.

LOWER TENSAS LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	Elk Ridge:				*Feet.*	*Feet.*	*Feet.*
1	Section 1	630	R.	Bobbitt & Linnan	900	780	3.2
2	Section 2	630	R.	do	900	810	3.2
3	Section 3	630	R.	do	700	650	3.2
4	Section 4	630	R.	do	900	690	3.2
5	Section 5	630	R.	do	800	700	3.2
6	Section 6	630	R.	do	800	750	3.2
	White Oak Lake, Lot 1:						
7	Section 1	630.5	R.	do	800	790	3.1
8	Section 2	630.5	R.	do	900	910	3.3
9	Section 3	630.5	R.	do	1,000	950	3.2
10	Section 4	630.5	R.	do	900	850	3.1
11	Section 5	630.5	R.	do	800	810	3.0
12	Section 6	630.5	R.	do	800	795	3.4
	White Oak Lake, Lot 2:						
13	Section 1	632	R.	do	800	750	3.2
14	Section 2	632	R.	do	800	725½	3.0
15	Section 3	632	R.	do	800	740	2.8
16	Section 6	632	R.	do	800	690	2.9

Fourth district levees, 1903-4—Continued.

LOWER TENSAS LEVEE DISTRICT—Continued.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	White Oak Lake, Lot 3:				*Feet.*	*Feet.*	*Feet.*
17	Section 1	632	R.	Bobbitt & Linnan	800	700	2.8
18	Section 2	632	R.	do	800	675	2.8
19	Section 3	632	R.	do	900	725	2.5
20	Section 4	632	R.	do	1,000	740	2.7
21	Section 5	632	R.	do	1,000	700	2.6
22	Section 6	632	R.	do	900	600	2.4
	Southwood:						
23	Section 1	633	R.	do	900	550	2.8
24	Section 2	633	R.	do	900	500	2.9
25	Section 3	633	R.	do	900	400	3.1
26	Section 4	633	R.	do	1,000	400	3.0
27	Section 5	633	R.	do	1,000	400	2.9
28	Section 6	633	R.	do	500	500	3.1
29	Vaucluse	686	R.	James R. Marlow	500	500	2.5
	Roseland:						
30	Section 5	730	R.	R. T. Clark	1,300	1,740	5.1
31	Section 6	730	R.	do	1,400	1,850	5.4
	Wildwood:						
32	Section 1	734	R.	C. H. Whipple	1,360	1,360	6.2
33	Section 2	730	R.	do	1,100	1,360	6.3
34	Section 3	730	R.	do	1,400	1,750	6.8
35	Section 6	730	R.	do	1,300	1,536	6.7
	Home Place:						
36	Section 5	736	R.	R. T. Clark	900	1,000	7.2

No.	Name of levee.	Date of contract.	Work completed.	Total yardage paid for.	Price per cubic yard.	Total cost.	Grade of levee above highest known water.
	Elk Ridge:				*Cents.*		*Feet.*
1	Section 1	July 1, 1903	Feb. 8, 1904	12,881.48	24.74	$3,186.88	5
2	Section 2	do	Feb. 25, 1904	12,527.32	24.74	3,099.26	5
3	Section 3	do	do	12,100.00	24.74	2,993.54	5
4	Section 4	do	do	13,347.90	24.74	3,302.27	5
5	Section 5	do	do	13,371.58	24.74	3,308.13	5
6	Section 6	do	Feb. 8, 1904	12,507.38	24.74	3,094.33	5
	White Oak Lake, Lot 1:						
7	Section 1	do	Jan. 22, 1904	12,343.89	24.74	3,053.88	5
8	Section 2	do	Jan. 29, 1904	13,463.18	24.74	3,330.79	5
9	Section 3	do	Feb. 3, 1904	13,251.46	24.74	3,278.41	5
10	Section 4	do	Dec. 30, 1903	12,036.53	24.74	2,977.83	5
11	Section 5	do	Dec. 23, 1903	11,786.85	24.74	2,916.07	5
12	Section 6	do	do	12,801.56	24.74	3,167.11	5
	White Oak Lake, Lot 2:						
13	Section 1	do	Dec. 16, 1903	12,688.82	24.74	3,139.21	5
14	Section 2	do	do	13,256.00	24.74	3,279.53	5
15	Section 3	do	Dec. 2, 1903	13,583.62	24.74	3,360.59	5
16	Section 6	do	Apr. 5, 1904	11,566.84	24.74	2,861.64	5
	White Oak Lake, Lot 3:						
17	Section 1	do	Mar. 31, 1904	11,864.02	24.74	2,935.16	5
18	Section 2	do	Apr. 3, 1904	11,961.90	24.74	2,959.37	5
19	Section 3	do	Feb. 5, 1904	12,837.30	24.74	3,175.95	5
20	Section 4	do	Jan. 22, 1904	13,069.19	24.74	3,233.32	5
21	Section 5	do	Dec. 20, 1903	13,600.43	24.74	3,364.75	5
22	Section 6	do	Dec. 2, 1903	12,500.99	24.74	3,092.74	5
	Southwood:						
23	Section 1	do	Oct. 17, 1903	12,370.78	24.74	3,060.53	5
24	Section 2	do	do	12,715.88	24.74	3,145.91	5
25	Section 3	do	Sept. 24, 1903	12,872.47	24.74	3,184.65	5
26	Section 4	do	Dec. 1, 1903	12,348.90	24.74	3,055.12	5
27	Section 5	do	Sept. 21, 1903	12,696.34	24.74	3,141.07	5
28	Section 6	do	do	10,976.57	24.74	2,715.60	5
29	Vaucluse	June 9, 1903	June 30, 1903	7,459.13	15.48	1,154.67	5
	Roseland:						
30	Section 5	July 28, 1902	June 6, 1903	11,993.39	11.50	1,379.24	5
31	Section 6	do	June 30, 1903	12,665.94	11.50	1,456.58	5
	Wildwood:						
32	Section 1	Nov. 10, 1902	Nov. 28, 1903	14,941.02	12.70	1,897.51	5
33	Section 2	do	Jan. 4, 1904	11,503.97	12.70	1,461.00	5
34	Section 3	do	Dec. 29, 1903	12,743.58	12.70	1,618.43	5
35	Section 6	do	Mar. 3, 1904	17,579.53	12.70	2,232.60	5
	Home Place:						
36	Section 5	do	June 30, 1903	13,354.62	11.50	1,535.78	5

Fourth district levees, 1903-4—Continued.

LOWER TENSAS LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Distance from center of levee to river bank.			Nature of bank.
		Crown.	Land slope.	River slope.			Least.	Greatest.	Average.	
	Elk Ridge:					*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	Section 1........	8	3 to 1	3 to 1	Enlargement.	22.0	10,000	10,100	10,060	Caving.
2	Section 2........	8	3 to 1	3 to 1	....do....	22.5	9,850	10,000	9,960	Do.
3	Section 3........	8	3 to 1	3 to 1	....do....	23.5	9,800	9,850	9,820	Do.
4	Section 4........	8	3 to 1	3 to 1	....do....	23.5	9,760	9,800	9,780	Do.
5	Section 5........	8	3 to 1	3 to 1	....do....	23.0	9,690	9,710	9,695	Do.
6	Section 6........	8	3 to 1	3 to 1	....do....	22.0	9,600	9,660	9,650	Do.
	White Oak Lake, Lot 1:									
7	Section 1........	8	3 to 1	3 to 1	....do....	20.0	9,580	9,600	9,590	Do.
8	Section 2........	8	3 to 1	3 to 1	....do....	20.5	9,370	9,580	9,480	Do.
9	Section 3........	8	3 to 1	3 to 1	....do....	23.0	9,060	9,370	9,190	Do.
10	Section 4........	8	3 to 1	3 to 1	....do....	21.5	8,760	9,050	8,870	Do.
11	Section 5........	8	3 to 1	3 to 1	....do....	20.0	8,620	8,760	8,720	Do.
12	Section 6........	8	3 to 1	3 to 1	....do....	20.0	8,410	8,620	8,530	Do.
	White Oak Lake, Lot 2:									
13	Section 1........	8	3 to 1	3 to 1	....do....	20.0	8,200	8,410	8,300	Do.
14	Section 2........	8	3 to 1	3 to 1	....do....	20.0	7,950	8,200	8,060	Do.
15	Section 3........	8	3 to 1	3 to 1	....do....	21.0	7,500	7,700	7,670	Do.
16	Section 6........	8	3 to 1	3 to 1	....do....	20.5	6,350	6,700	6,500	Do.
	White Oak Lake, Lot 3:									
17	Section 1........	8	3 to 1	3 to 1	....do....	20.5	6,100	6,350	6,225	Do.
18	Section 2........	8	3 to 1	3 to 1	....do....	20.5	5,850	6,100	6,000	Do.
19	Section 3........	8	3 to 1	3 to 1	....do....	20.0	5,700	5,850	5,775	Do.
20	Section 4........	8	3 to 1	3 to 1	....do....	20.0	5,300	5,700	5,490	Do.
21	Section 5........	8	3 to 1	3 to 1	....do....	19.5	4,900	5,300	5,150	Do.
22	Section 6........	8	3 to 1	3 to 1	....do....	19.0	4,510	4,900	4,700	Do.
	Southwood:									
23	Section 1........	8	3 to 1	3 to 1	....do....	20.0	4,000	4,510	4,260	Do.
24	Section 2........	8	3 to 1	3 to 1	....do....	20.0	3,400	4,000	3,710	Do.
25	Section 3........	8	3 to 1	3 to 1	....do....	20.0	2,800	3,400	3,130	Do.
26	Section 4........	8	3 to 1	3 to 1	....do....	19.5	2,200	2,800	2,490	Do.
27	Section 5........	8	3 to 1	3 to 1	....do....	19.5	1,600	2,200	1,940	Do.
28	Section 6........	8	3 to 1	3 to 1	....do....	20.5	1,200	1,600	1,375	Do.
29	Vaucluse............	8	3 to 1	3 to 1	New.....	12.9	6,000	6,200	6,090	Do.
	Roseland:									
30	Section 5........	8	3 to 1	3 to 1	Enlargement.	10.0	450	552	490	Stationary.
31	Section 6........	8	3 to 1	3 to 1	....do....	10.3	470	550	515	Do.
	Wildwood:									
32	Section 1........	8	3 to 1	3 to 1	....do....	10.2	3,710	3,800	3,760	Do.
33	Section 2........	8	3 to 1	3 to 1	....do....	9.8	3,390	3,500	3,460	Do.
34	Section 3........	8	3 to 1	3 to 1	....do....	9.4	3,300	3,350	3,320	Do.
35	Section 6........	8	3 to 1	3 to 1	....do....	8.4	3,180	3,250	3,200	Do.
	Home Place:									
36	Section 5........	8	3 to 1	3 to 1	....do....	12.0	3,350	3,480	3,240	Do.

LOWER TENSAS LEVEE DISTRICT (UNCOMPLETED LEVEES).

No.	Name of levee.	Mile below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	White Oak Lake, Lot 2:				*Feet.*	*Feet.*	*Feet.*
1	Section 4.............	631	R.	Bobbitt & Linnan....	800	715	5
2	Section 5.............	631	R.	.....do...............	800	700	5

Fourth district levees, 1903-4—Continued.

LOWER TENSAS LEVEE DISTRICT (UNCOMPLETED LEVEES)—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.	
	White Oak Lake, Lot 2:							
1	Section 4	8	3 to 1	3 to 1	Enlargement.	2.6	19.6	July 1, 1903
2	Section 5	8	3 to 1	3 to 1	....do....	2.4	19.9	Do.

No.	Name of levee.	Total yardage.	Price per cubic yard.	Distance from center of levee to river bank.			Nature of bank.	Condition of contract.
				Least.	Greatest.	Average.		
	White Oak Lake, Lot 2:		*Cents.*	*Feet.*	*Feet.*	*Feet.*		
1	Section 4	12,617.80	24.74	7,100	7,420	7,280	Caving	No work done.
2	Section 5	12,973.96	24.74	6,700	7,100	6,890	....do....	43 per cent completed.

ATCHAFALAYA LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	Red River Landing:				*Feet.*	*Feet.*	*Feet.*
1	Section 1	766	R.	James R. Marlow	1,105	1,100	17.0
2	Section 2	766	R.	....do	1,000	1,000	16.8
	Smithland:						
3	Section 1	767	R.	Batt O'Brien	1,183	1,500	15.0
	Torwood:						
4	Section 1	875	R.	C. H. Whipple	600	1,100	13.1
5	Section 2	875	R.	....do	700	1,200	11.5
	Lakeside:						
6	Section 1	877	R.	....do	673	1,000	12.1
7	Section 2	877	R.	....do	584	900	12.9

No.	Name of levee.	Date of contract.	Work completed.	Total yardage paid for.	Price per cubic yard.	Total cost.	Grade of levee above highest known water.
	Red River Landing:				*Cents.*		*Feet.*
1	Section 1	Dec. 11, 1902	Apr. 12, 1904	13,151.02	19.25	$2,531.57	4.4
2	Section 2	....do....	Apr. 5, 1904	12,682.85	19.25	2,441.45	4.4
	Smithland:						
3	Section 1	Sept. 12, 1902	Sept. 15, 1903	13,847.61	14.73	2,039.75	4.2
	Torwood:						
4	Section 1	Oct. 30, 1903	Jan. 23, 1904	14,020.42	14.97	2,098.85	4.2
5	Section 2	....do....	....do....	12,874.66	14.97	1,927.33	4.2
	Lakeside:						
6	Section 1	....do....	Dec. 29, 1903	13,496.81	14.97	2,020.47	4.2
7	Section 2	....do....	Dec. 18, 1903	12,802.19	14.97	1,916.49	4.2

Fourth district levees, 1903–4—Continued.

ATCHAFALAYA LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Distance from center of levee to river bank.			Nature of bank.
		Crown.	Land slope.	River slope.			Least.	Greatest.	Average.	
	Red River Landing:					*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	Section 1	8	3 to 1	3 to 1	Enlargement.	1.7	660	1,070	850	Caving.
2	Section 2	8	3 to 1	3 to 1	.....do	1.7	1,120	1,150	1,130	Do.
	Smithland:									
3	Section 1	8	3 to 1	3 to 1	.....do	1.8	560	1,300	1,050	Do.
	Torwood:									
4	Section 1	8	3 to 1	3 to 1	New	....	45,110	46,220	45,690	Stationary.
5	Section 2	8	3 to 1	3 to 1	.....do	....	45,215	46,220	45,760	Do.
	Lakeside:									
6	Section 1	8	3 to 1	3 to 1	.....do	....	45,200	46,350	45,775	Do.
7	Section 2	8	3 to 1	3 to 1	.....do	....	45,350	46,500	45,900	Do.

ATCHAFALAYA LEVEE DISTRICT (UNCOMPLETED LEVEES).

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	Red River Landing:				*Feet.*	*Feet.*	*Feet.*
1	Section 2	766	R.	James R. Marlow	1,000	1,000	17.0
2	Section 3	766	R.	.....do	1,000	1,000	17.0
3	Section 5	766	R.	.....do	1,100	1,100	18.0
4	Section 6	766	R.	.....do	700	700	19.5
	Henriette:						
5	Section 1	768	R.	C. H. Whipple	1,300	1,600	13.0
6	Section 2	768	R.	.....do	1,600	2,000	12.5
7	Section 3	768	R.	.....do	1,400	1,800	12.3
8	Section 4	768	R.	.....do	1,500	1,900	12.0
9	Section 5	768	R.	.....do	1,300	1,700	12.0
10	Section 6	768	R.	.....do	1,700	2,100	11.8
	Latenache:						
11	Section 1	770	R.	.....do	2,000	2,400	12.0
12	Section 2	770	R.	.....do	2,200	2,600	11.2
13	Section 3	770	R.	.....do	2,200	2,600	10.5
	New Texas:						
14	Section 1	786	R.	M. L. Linnan	1,375	1,300	19.5
15	Section 2	786	R.	.....do	1,400	1,380	16.5
16	Section 3	786	R.	.....do	900	890	16.8
17	Section 4	786	R.	.....do	900	900	17.3
18	Section 5	786	R.	.....do	1,200	1,200	16.0
19	Section 6	786	R.	.....do	1,600	1,600	16.2
20	Section 7	786	R.	.....do	1,300	1,300	17.5
21	Section 8	786	R.	.....do	1,493	1,500	18.5

No.	Name of levee.	Date of contract.	Total yardage.	Price per cubic yard.	Distance from center of levee to river bank.			Grade of levee above highest known water.
					Least.	Greatest.	Average.	
	Red River Landing:			*Cents.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	Section 2	Dec. 11, 1902	13,258.77	19.25	1,030	1,100	1,070	4.2
2	Section 3	.....do	13,029.75	19.25	1,060	1,120	1,090	4.2
3	Section 5	.....do	12,766.10	19.25	1,100	1,320	1,200	4.2
4	Section 6	.....do	11,340.33	19.25	1,310	1,370	1,320	4.2
	Henrietta:							
5	Section 1	Aug. 28, 1903	12,298.37	19.50	43,000	43,500	43,250	3.9
6	Section 2	.....do	12,451.50	19.50	43,000	43,500	43,250	3.6
7	Section 3	.....do	12,574.21	19.50	43,000	43,500	43,250	3.4
8	Section 4	.....do	12,967.23	19.50	45,000	46,000	45,500	3.4
9	Section 5	.....do	12,466.39	19.50	45,000	46,000	45,550	3.5
10	Section 6	.....do	12,421.97	19.50	45,000	46,000	45,500	3.7
	Latenache:							
11	Section 1	.....do	13,086.78	15.50	45,000	46,000	45,500	4.3
12	Section 2	.....do	13,382.97	15.50	45,000	46,000	45,500	4.3
13	Section 3	.....do	13,695.24	15.50	45,000	46,000	45,500	4.3

Fourth district levees, 1903-4—Continued.

ATCHAFALAYA LEVEE DISTRICT (UNCOMPLETED LEVEES)—Continued.

No.	Name of levee.	Date of contract.	Total yardage.	Price per cubic yard.	Distance from center of levee to river bank.			Grade of levee above highest known water.
					Least.	Greatest.	Average.	
	New Texas:			*Cents.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
14	Section 1	Dec. 21, 1903	12,032.42	21.74	570	615	600	4.3
15	Section 2	do	12,220.89	21.74	570	640	620	4.2
16	Section 3	do	12,185.24	21.74	360	440	370	4.2
17	Section 4	do	12,803.24	21.74	360	440	400	4.2
18	Section 5	do	12,047.89	21.74	350	1,400	1,000	4.2
19	Section 6	do	11,602.20	21.74	1,420	1,650	1,450	4.1
20	Section 7	do	11,212.05	21.74	1,420	1,650	1,440	4.1
21	Section 8	do	12,253.77	21.74	1,570	1,800	1,700	4.0

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Nature of bank.	Condition of contract.
		Crown.	Land slope.	River slope.				
	Red River Landing:							
1	Section 2	8	3 to 1	3 to 1	Enlargement.	1.6	Caving	No work done.
2	Section 3	8	3 to 1	3 to 1	do	1.7	do	Do.
3	Section 5	8	3 to 1	3 to 1	do	1.8	do	Do.
4	Section 6	8	3 to 1	3 to 1	do	2.0	Stationary	Do.
	Henrietta:							
5	Section 1	8	3 to 1	3 to 1	do	1.3	do	Do.
6	Section 2	8	3 to 1	3 to 1	do	1.2	do	Do.
7	Section 3	8	3 to 1	3 to 1	do	1.0	do	Do.
8	Section 4	8	3 to 1	3 to 1	do	1.2	do	Do.
9	Section 5	8	3 to 1	3 to 1	do	1.0	do	Do.
10	Section 6	8	3 to 1	3 to 1	do	1.0	do	Do.
	Latenache:							
11	Section 1	8	3 to 1	3 to 1	do	1.0	do	53 per cent in place.
12	Section 2	8	3 to 1	3 to 1	do	1.2	do	82 per cent in place.
13	Section 3	8	3 to 1	3 to 1	do	1.0	do	20 per cent in place.
	New Texas:							
14	Section 1	8	3 to 1	3 to 1	do	1.3	Caving	No work done.
15	Section 2	8	3 to 1	3 to 1	do	1.5	do	Do.
16	Section 3	8	3 to 1	5 to 1	do	1.7	do	Do.
17	Section 4	8	3 to 1	3 to 1	do	2.0	do	Do.
18	Section 5	8	3 to 1	3 to 1	do	1.6	do	Do.
19	Section 6	8	3 to 1	3 to 1	do	0.8	do	Do.
20	Section 7	8	3 to 1	3 to 1	do	1.0	do	Do.
21	Section 8	8	3 to 1	3 to 1	do	1.8	do	Do.

LAFOURCHE LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	St. Clair:				*Feet.*	*Feet.*	*Feet.*
1	Section 1	899	R.	Pat Deely	1,209	1,260	13.1
2	Section 2	899	R.	do	1,300	1,290	12.8
3	Section 3	899	R.	do	1,700	1,755	13.2
4	Section 4	899	R.	do	1,300	1,470	13.3
	St. Cecile:						
5	Section 1	900	R.	do	1,100	900	13.2
6	Section 2	900	R.	do	1,500	1,600	13.6
7	Section 3	900	R.	do	1,600	1,370	12.5
8	Section 4	900.5	R.	do	1,415	1,410	13.0
	St. James:						
9	Section 1	904	R.	Menzies & Co.	1,312	1,180	13.8
10	Section 2	904	R.	do	1,300	1,170	14.3
11	Section 3	904	R.	do	1,300	1,160	15.1
12	Section 4	904	R	do	1,100	990	16.1
13	Section 5	904	R.	do	1,200	1,080	13.6

Fourth district levees, 1903-4—Continued.

LAFOURCHE LEVEE DISTRICT—Continued.

No.	Name of levee.	Date of contract.	Work completed.	Total yardage paid for.	Price per cubic yard.	Total cost.	Grade of levee above highest known water.
	St. Clair:				*Cents.*		*Feet.*
1	Section 1	Aug. 27, 1903	Oct. 31, 1903	11,697.67	16.25	$1,900.87	4.1
2	Section 2	do	Nov. 12, 1903	11,859.45	16.25	1,927.16	4.0
3	Section 3	do	Nov. 19, 1903	12,003.64	16.25	1,950.50	4.0
4	Section 4	do	Nov. 27, 1903	11,373.19	16.25	1,848.48	4.0
	St. Cecile:						
5	Section 1	do	Dec. 2, 1903	11,460.53	15.25	1,747.73	4.0
6	Section 2	do	Dec. 11, 1903	12,077.98	15.25	1,841.89	4.0
7	Section 3	do	Jan. 4, 1904	12,349.58	15.25	1,883.31	4.0
8	Section 4	do	Dec. 28, 1903	11,875.31	15.25	1,810.98	4.0
	St. James:						
9	Section 1	Dec. 3, 1902	Feb. 29, 1904	12,349.89	14.50	1,790.73	3.9
10	Section 2	do	Mar. 4, 1904	12,814.48	14.50	1,858.10	3.9
11	Section 3	do	Mar. 30, 1904	12,702.93	14.50	1,831.92	3.9
12	Section 4	do	Partly completed.	15,000.00	14.50	2,175.00	3.9
13	Section 5						

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Distance from center of levee to river bank.			Nature of bank.
		Crown.	Land slope.	River slope.			Least.	Greatest.	Average.	
	St. Clair:					*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	Section 1	8	3 to 1	3 to 1	Enlargement.	2.2	187	280	232	Washing.
2	Section 2	8	3 to 1	3 to 1	do	2.4	219	278	248	Do.
3	Section 3	8	3 to 1	3 to 1	do	2.0	246	344	302	Do.
4	Section 4	8	3 to 1	3 to 1	do	1.8	300	340	320	Do.
	St. Cecile:									
5	Section 1	8	3 to 1	3 to 1	do	1.5	218	300	270	Do.
6	Section 2	8	3 to 1	3 to 1	do	1.4	160	218	193	Do.
7	Section 3	8	3 to 1	3 to 1	do	1.4	150	350	226	Do.
8	Section 4	8	3 to 1	3 to 1	do	1.7	180	220	205	Do.
	St. James:									
9	Section 1	8	3 to 1	3 to 1	do	2.3	320	450	400	Caving.
10	Section 2	8	3 to 1	3 to 1	do	2.4	375	535	405	Do.
11	Section 3	8	3 to 1	3 to 1	do	2.4	340	525	420	Washing.
12	Section 4	8	3 to 1	3 to 1	do	2.4	270	380	320	Do.
13	Section 5	8	3 to 1	3 to 1	do	2.2	290	365	325	Do.

LAFOURCHE LEVEE DISTRICT (UNCOMPLETED LEVEES).

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	St. James:				*Feet.*	*Feet.*	*Feet.*
1	Section 4	904.5	R.	Menzies & Co	1,100	990	16.1
2	Section 5	904.5	R.	do	1,200	1,080	13.6
3	Section 6	904.5	R.	do	1,450	1,300	11.7
	Chopin:						
4	Section 1	906	R.	do	1,564	1,500	14.1
5	Section 2	906	R.	do	1,644	1,690	15.2

Fourth district levees, 1903-4—Continued.

LAFOURCHE LEVEE DISTRICT (UNCOMPLETED LEVEES)—Continued.

No.	Name of levee.	Date of contract.	Total yardage.	Price per cubic yard.	Distance from center of levee to river bank.			Grade of levee above highest known water.
					Least.	Greatest.	Average.	
	St. James:			*Cents.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	Section 4	Dec. 3, 1902	15,311.62	14.50	270	380	330	3.9
2	Section 5	do	13,485.11	14.50	290	365	325	3.9
3	Section 6	do	13,554.65	14.50	165	390	260	3.9
	Chopin:							
4	Section 1	do	5,115.87	14.50	600	730	660	3.9
5	Section 2	do	4,996.81	14.50	570	765	595	3.9

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Nature of bank.	Condition of contract.
		Crown.	Land slope.	River slope.				
	St. James:					*Feet.*		
1	Section 4	8	3 to 1	3 to 1	Enlargement.	2.4	Washing	92 per cent in place.
2	Section 5	8	3 to 1	3 to 1	do	2.2	do	85 per cent in place.
3	Section 6	8	3 to 1	3 to 1	do	2.1	do	No work done.
	Chopin:							
4	Section 1	8	3 to 1	3 to 1	do	2.0	do	Do.
5	Section 2	8	3 to 1	3 to 1	do	1.8	do	Do.

BARATARIA LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	Concession:				*Feet.*	*Feet.*	*Feet.*
1	Section 2	987	R.	Geo. H. Conrad	2,500	2,890	8.7
2	Section 3	987	R.	do	2,140	2,030	10.0
3	Smith	1,037	R.	Michael Cullen	2,548	2,500	6.0

No.	Name of levee.	Date of contract.	Work completed.	Total yardage paid for.	Price per cubic yard.	Total cost.	Grade of levee above highest known water.
	Concession:				*Cents.*		*Feet.*
1	Section 2	July 26, 1902	Sept. 10, 1903	13,115.68	14.75	$1,934.56	2.4
2	Section 3	do	do	12,521.18	14.75	1,846.87	2.3
3	Smith	Sept. 2, 1903	Jan. 27, 1904	17,119.99	16.50	2,824.79	2.0

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Distance from center of levee to river bank.			Nature of bank.
		Crown.	Land slope.	River slope.			Least.	Greatest.	Average.	
	Concession:						*Feet.*	*Feet.*	*Feet.*	
1	Section 2	8	3 to 1	3 to 1	Enlargement.	1.5	100	228	196	Caving.
2	Section 3	8	3 to 1	3 to 1	do	1.7	190	208	190	Do.
3	Smith	8	3 to 1	3 to 1	New		115	275	175	Do.

Fourth district levees, 1903-4—Continued.

PONTCHARTRAIN LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	Dicharry:				*Feet.*	*Feet.*	*Feet.*
1	Section 1	882	L.	C. D. Leeper	1,115	1,100	16.4
2	Section 2	882	L.	do	1,000	1,100	17.9
3	Section 3	882	L.	do	1,200	1,200	18.7
4	Section 4	882	L.	do	1,100	1,100	16.9
5	Section 5	882	L.	do	1,000	1,100	14.1
	Eighty-one Mile Point:						
6	Section 1	883	L.	do	1,100	1,100	14.8
7	Section 2	883	L.	do	1,300	1,320	12.7
	Uncle Sam:						
8	Section 1	901	L.	R. T. Clark	1,225	1,220	13.1
9	Section 2	901	L.	do	1,200	1,195	12.5
10	Section 3	901	L.	do	1,278	1,278	12.4
11	Section 4	901	L.	do	1,100	1,062	12.2
12	Section 5	901	L.	do	1,300	1,295	12.0
	Como:						
13	Section 1	902	L.	do	678	600	12.6
14	Section 2	902	L.	do	612	600	13.0
	Convent:						
15	Section 1	903	L.	do	1,300	1,302	13.1
16	Section 2	903	L.	do	1,200	1,210	13.0
17	Section 3	903	L.	do	1,200	1,200	12.5
18	Section 4	903	L.	do	1,200	1,200	13.3
19	Section 5	903	L.	do	1,253	1,274	13.6
	Thibodeaux						
20	Section 1	903.5	L.	do	542	510	13.6
21	Section 2	903.5	L.	do	516	510	13.1
	College Point:						
22	Section 1	904	L.	do	1,200	1,300	12.1
23	Section 2	904	L.	do	1,400	1,900	11.5
24	Section 3	904	L.	do	1,200	3,000	13.1
	Belmont:						
25	Section 4	908	L.	do	1,100	1,000	15.4
	Hester:						
26	Section 3	909	L.	do	1,400	1,336	13.6
	Poche:						
27	Section 1	911	L.	do	1,298	1,264	12.8
28	Section 2	911	L.	do	1,300	1,298	12.7
29	Section 3	911	L.	do	1,300	1,300	12.1
30	Section 4	911	L.	do	1,466	1,466	11.8
	St. Joseph Church:						
31	Section 1	912	L.	do	1,534	1,530	12.2
32	Section 2	912	L.	do	1,100	1,050	12.6
33	Section 3	912	L.	do	700	660	11.7
34	Section 4	912	L.	do	600	600	12.0
35	Section 5	912	L.	do	1,180	1,200	11.4
	Mount Airey:						
36	Section 3	915	L.	Menzies & Co	800	760	15.1
37	Section 4	915	L.	do	800	750	15.1
38	Section 5	915	L.	do	819	780	13.5
	Laplace:						
39	Section 1	927	L.	R. T. Clark	1,800	1,700	13.5
40	Section 2	927	L.	do	1,800	1,700	11.8
41	Section 3	927	L.	do	2,000	1,890	11.0
42	Section 4	927	L.	do	2,100	2,000	11.7
43	Section 5	927	L.	do	2,190	2,000	12.6

Fourth district levees, 1903-4—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

No.	Name of levee.	Date of contract.	Work completed.	Total yardage paid for.	Price per cubic yard.	Total cost.	Grade of levee above highest known water.
	Dicharry:				*Cents.*		*Feet.*
1	Section 1	July 22, 1903	Jan. 7, 1904	13,462.55	13.49	$1,816.10	4.2
2	Section 2	do	do	11,315.44	13.49	1,526.45	4.1
3	Section 3	do	Dec. 21, 1903	11,966.01	13.49	1,614.21	3.9
4	Section 4	do	Oct. 31, 1903	12,206.25	13.49	1,646.62	3.8
5	Section 5	do	Dec. 27, 1903	11,487.48	13.49	1,548.66	4.0
	Eighty-one Mile Point:						
6	Section 1	do	Jan. 16, 1904	11,374.17	13.49	1,804.18	4.2
7	Section 2	do	do	7,673.18	13.49	1,035.11	4.0
	Uncle Sam:						
8	Section 1	Feb. 24, 1903	Sept. 26, 1903	12,341.28	12.72	1,569.81	4.0
9	Section 2	do	Oct. 27, 1903	12,218.16	12.72	1,554.15	4.0
10	Section 3	do	do	12,646.68	12.72	1,608.66	4.0
11	Section 4	do	Sept. 16, 1903	10,573.33	12.72	1,344.93	4.0
12	Section 5	do	Nov. 27, 1903	12,773.47	12.72	1,624.78	4.0
	Como:						
13	Section 1	July 6, 1903	Aug. 31, 1903	13,430.91	13.00	1,746.02	4.0
14	Section 2	do	do	12,326.03	13.00	1,602.44	4.0
	Convent:						
15	Section 1	Feb. 24, 1903	Oct. 28, 1903	12,734.10	13.95	1,776.41	4.0
16	Section 2	do	Jan. 10, 1904	11,571.07	13.95	1,604.16	4.1
17	Section 3	do	Dec. 24, 1903	12,233.59	13.95	1,706.58	4.1
18	Section 4	do	Sept. 26, 1903	12,231.24	13.95	1,706.26	4.0
19	Section 5	do	Nov. 4, 1903	11,768.97	13.95	1,641.77	3.8
	Thibodeaux:						
20	Section 1	July 6, 1903	Sept. 2, 1903	13,532.01	13.95	1,887.71	4.0
21	Section 2	do	do	12,127.53	13.95	1,691.75	4.0
	College Point:						
22	Section 1	Feb. 24, 1903	Oct. 3, 1903	11,078.29	13.95	1,545.42	3.9
23	Section 2	do	Dec. 14, 1903	12,977.73	13.95	1,810.39	3.8
24	Section 3	do	Jan. 14, 1904	11,057.77	13.95	1,542.56	3.8
	Belmont:						
25	Section 4	do	Apr. 5, 1904	13,470.39	18.45	2,485.29	3.9
	Hester:						
26	Section 3	do	Apr. 6, 1904	11,135.51	18.45	2,054.50	3.7
	Poche:						
27	Section 1	do	Aug. 4, 1903	10,127.63	12.72	1,288.23	3.8
28	Section 2	do	Sept. 7, 1903	10,496.44	12.72	1,335.15	3.8
29	Section 3	do	Sept. 28, 1903	10,428.51	12.72	1,326.51	3.8
30	Section 4	do	Aug. 7, 1903	9,873.64	12.72	1,255.93	3.7
	St. Joseph Church:						
31	Section 1	do	Nov. 3, 1903	11,857.13	12.72	1,508.28	3.7
32	Section 2	do	Dec. 8, 1903	11,833.31	12.72	1,505.19	3.7
33	Section 3	do	Jan. 18, 1904	12,528.59	12.72	1,593.63	3.7
34	Section 4	do	Feb. 17, 1904	11,366.49	12.72	1,445.81	3.9
35	Section 5	do	Feb. 26, 1904	11,374.11	12.72	1,446.79	3.8
	Mount Airey:						
36	Section 3	July 22, 1902	June 3, 1903	3,333.90	13.25	441.74	4.1
37	Section 4	do	do	3,523.09	13.25	466.81	4.1
38	Section 5	do	do	3,794.78	13.25	442.81	4.1
	Laplace:						
39	Section 1	Feb. 24, 1903	Dec. 16, 1903	13,174.87	12.72	1,675.84	3.5
40	Section 2	do	Oct. 31, 1903	11,738.02	12.72	1,493.08	3.5
41	Section 3	do	Feb. 3, 1904	12,820.62	12.72	1,630.78	3.4
42	Section 4	do	Mar. 15, 1904	13,051.82	12.72	1,660.19	3.4
43	Section 5	do	Sept. 19, 1903	11,199.63	12.72	1,424.59	3.4

Fourth district levees 1903-4—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Distance from center of levee to river bank.			Nature of bank.
		Crown.	Land slope.	River slope.			Least.	Greatest.	Average.	
	Dicharry:					*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	Section 1....	8	3 to 1	3 to 1	Enlargement.	3.5	494	650	570	Caving.
2	Section 2....	8	3 to 1	3 to 1	.....do....	3.4	560	650	600	Do.
3	Section 3....	8	3 to 1	3 to 1	.....do....	2.8	540	600	570	Do.
4	Section 4....	8	3 to 1	3 to 1	.....do....	2.6	285	595	420	Do.
5	Section 5....	8	3 to 1	3 to 1	.....do....	3.3	330	520	425	Do.
	Eighty-one Mile Point:									
6	Section 1....	8	3 to 1	3 to 1	.....do....	3.5	416	1,155	780	Stationary.
7	Section 2....	8	3 to 1	3 to 1	.....do....	2.8	580	1,090	835	Do.
	Uncle Sam:									
8	Section 1....	8	3 to 1	3 to 1	.....do....	2.8	250	320	275	Do.
9	Section 2....	8	3 to 1	3 to 1	.....do....	2.9	230	270	250	Do.
10	Section 3....	8	3 to 1	3 to 1	.....do....	3.4	140	250	175	Do.
11	Section 4....	8	3 to 1	3 to 1	.....do....	3.5	120	160	140	Do.
12	Section 5....	8	3 to 1	3 to 1	.....do....	3.2	130	150	140	Do.
	Como:									
13	Section 1....	8	3 to 1	3 to 1	New......	....	130	250	170	Washing.
14	Section 2....	8	3 to 1	3 to 1	.....do....	....	140	250	155	Do.
	Convent:									
15	Section 1....	8	3 to 1	3 to 1	Enlargement.	3.4	120	170	140	Do.
16	Section 2....	8	3 to 1	3 to 1	.....do....	3.2	150	210	180	Do.
17	Section 3....	8	3 to 1	3 to 1	.....do....	3.4	115	215	160	Do.
18	Section 4....	8	3 to 1	3 to 1	.....do....	3.3	120	145	130	Do.
19	Section 5....	8	3 to 1	3 to 1	.....do....	3.3	90	220	140	Do.
	Thibodeaux:									
20	Section 1....	8	3 to 1	3 to 1	New......	....	130	200	170	Caving.
21	Section 2....	8	3 to 1	3 to 1	.....do....	....	125	175	150	Do.
	College Point:									
22	Section 1....	8	3 to 1	3 to 1	Enlargement.	3.0	90	150	120	Stationary.
23	Section 2....	8	3 to 1	3 to 1	.....do....	3.0	77	190	105	Do.
24	Section 3....	8	3 to 1	3 to 1	.....do....	2.9	160	350	230	Do.
	Belmont:									
25	Section 4....	8	3 to 1	3 to 1	.....do....	2.6	430	450	440	Washing.
	Hester:									
26	Section 3....	8	3 to 1	3 to 1	.....do....	2.0	285	500	380	Stationary.
	Poche:									
27	Section 1....	8	3 to 1	3 to 1	.....do....	3.2	235	280	260	Washing.
28	Section 2....	8	3 to 1	3 to 1	.....do....	3.1	150	266	200	Do.
29	Section 3....	8	3 to 1	3 to 1	.....do....	3.2	105	154	125	Do.
30	Section 4....	8	3 to 1	3 to 1	.....do....	2.5	111	180	127	Stationary.
	St. Joseph Church:									
31	Section 1....	8	3 to 1	3 to 1	.....do....	2.8	89	108	240	Do.
32	Section 2....	8	3 to 1	3 to 1	.....do....	3.1	90	129	310	Washing.
33	Section 3....	8	3 to 1	3 to 1	.....do....	3.1	170	208	310	Caving.
34	Section 4....	8	3 to 1	3 to 1	.....do....	3.1	185	220	350	Do.
35	Section 5....	8	3 to 1	3 to 1	.....do....	3.0	100	170	350	Washing.
	Mount Airey:									
36	Section 3....	8	3 to 1	3 to 1	Enlargement.	3.8	390	420	400	Caving.
37	Section 4....	8	3 to 1	3 to 1	.....do....	3.5	420	450	435	Do.
38	Section 5....	8	3 to 1	3 to 1	.....do....	4.0	450	350	500	Do.
	Laplace:									
39	Section 1....	8	3 to 1	3 to 1	.....do....	3.0	260	415	345	Stationary.
40	Section 2....	8	3 to 1	3 to 1	.....do....	3.0	360	408	370	Do.
41	Section 3....	8	3 to 1	3 to 1	.....do....	2.8	390	445	410	Washing.
42	Section 4....	8	3 to 1	3 to 1	.....do....	2.4	350	480	405	Do.
43	Section 5....	8	3 to 1	3 to 1	.....do....	2.9	240	492	345	Do.

Fourth district levees, 1903-4—Continued.

PONTCHARTRAIN LEVEE DISTRICT (UNCOMPLETED LEVEES).

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	Belmont:				*Feet.*	*Feet.*	*Feet.*
1	Section 1..........	908	L.	R. T. Clark...............	1,300	1,220	15.5
2	Section 2..........	908	L.	.....do.....................	1,200	1,121	15.6
3	Section 3..........	908	L.	.....do.....................	1,100	941	13.3
	Hester:						
4	Section 1..........	909	L.	.....do.....................	1,000	949	16.5
5	Section 2..........	909	L.	.....do.....................	1,100	1,054	15.4
6	Section 4..........	909	L.	.....do.....................	1,400	1,325	13.4
	Angelina:						
7	Section 1..........	917	L.	.....do.....................	894	843	18.9
8	Section 2..........	917	L.	.....do.....................	900	858	19.1
9	Section 3..........	917	L.	.....do.....................	833	790	19.0
	Reserve:						
10	Section 1..........	922	L.	Menzies & Co.............	1,697	1,665	10.0
11	Section 2..........	922	L.	.....do.....................	1,900	1,800	9.0
12	Section 3..........	922	L.	.....do.....................	1,500	1,300	9.9
13	Section 4..........	922	L.	.....do.....................	1,600	1,504	11.0
14	Section 5..........	922	L.	.....do.....................	1,300	1,317	10.9
	Cornland:						
15	Section 1..........	923.5	L.	.....do.....................	1,700	1,800	9.5
16	Section 2..........	923.5	L.	.....do.....................	1,900	1,847	10.4
17	Section 3..........	923.5	L.	.....do.....................	2,000	1,957	9.7
18	Section 4..........	923.5	L.	.....do.....................	1,600	1,585	10.8
19	Section 5..........	923.5	L.	.....do.....................	1,400	1,433	9.8
	Belle Point:						
20	Section 1..........	925	L.	.....do.....................	1,400	1,440	10.7
21	Section 2..........	925	L.	.....do.....................	1,700	1,789	11.4
22	Section 3..........	925	L.	.....do.....................	2,100	2,134	12.0
23	Section 4..........	925	L.	.....do.....................	2,100	2,087	11.8
24	Section 5..........	925	L.	.....do.....................	1,803	1,785	13.4

No.	Name of levee.	Date of contract.	Total yardage.	Price per cubic yard.	Distance from center of levee to river bank.			Above highest known water.
					Least.	Greatest.	Average.	
	Belmont:			*Cents.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	Section 1..........	Feb. 24, 1903	14,373.11	18.45	500	560	510	3.8
2	Section 2..........	.....do.......	13,831.73	18.45	460	590	515	3.8
3	Section 3..........	.....do.......	14,289.97	18.45	450	490	470	4.0
	Hester:							
4	Section 1..........	.....do.......	11,951.08	18.45	430	550	565	3.8
5	Section 2..........	.....do.......	13,070.36	18.45	350	675	495	3.8
6	Section 4..........	.....do.......	11,719.96	18.45	285	500	380	3.8
	Angelina:							
7	Section 1..........	.....do.......	9,431.81	24.87	490	550	520	3.8
8	Section 2..........	.....do.......	9,234.46	24.87	493	536	510	3.8
9	Section 3..........	.....do.......	9,277.01	24.87	525	560	530	3.7
	Reserve:							
10	Section 1..........	Jan. 19, 1904	13,670.09	12.95	133	210	167	3.7
11	Section 2..........	.....do.......	13,457.37	12.95	120	230	188	3.7
12	Section 3..........	.....do.......	12,923.00	12.95	145	300	217	3.7
13	Section 4..........	.....do.......	13,281.53	12.95	152	350	234	3.7
14	Section 5..........	.....do.......	13,905.74	12.95	225	243	232	3.7
	Cornland:							
15	Section 1..........	.....do.......	13,107.38	12.95	135	220	134	3.6
16	Section 2..........	.....do.......	13,368.09	12.95	90	270	175	3.6
17	Section 3..........	.....do.......	13,411.21	12.95	65	267	157	3.6
18	Section 4..........	.....do.......	13,410.77	12.95	70	140	112	3.6
19	Section 5..........	.....do.......	12,360.50	12.95	62	120	92	3.6
	Belle Point:							
20	Section 1..........	.....do.......	13,845.54	13.25	85	150	113	3.5
21	Section 2..........	.....do.......	13,653.86	13.25	140	229	173	3.5
22	Section 3..........	.....do.......	12,903.01	13.25	178	220	212	3.4
23	Section 4..........	.....do.......	12,248.34	13.25	178	220	206	3.4
24	Section 5..........	.....do.......	14,862.70	13.25	214	280	243	3.4

Fourth district levees, 1903-4—Continued.

PONTCHARTRAIN LEVEE DISTRICT (UNCOMPLETED LEVEES)—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Nature of bank.	Condition of contract.
		Crown.	Land slope.	River slope.				
	Belmont:					*Feet.*		
1	Section 1.........	8	3 to 1	3 to 1	Enlargement.	2.7	Caving	No work done.
2	Section 2.........	8	3 to 1	3 to 1	.....do....	3.0	.....do........	Do.
3	Section 3.........	8	3 to 1	3 to 1	.....do....	3.4	.....do........	Do.
	Hester:							
4	Section 1.........	8	3 to 1	3 to 1	.....do....	2.7	Stationary....	Do.
5	Section 2.........	8	3 to 1	3 to 1	.....do....	2.9	Caving	Do.
6	Section 4.........	8	3 to 1	3 to 1	.....do....	2.0	.....do........	2 per cent in place.
	Angelina:							
7	Section 1.........	8	3 to 1	3 to 1	.....do....	3.4	.....do........	No work done
8	Section 2.........	8	3 to 1	3 to 1	.....do....	3.2	.....do........	20 per cent in place.
9	Section 3.........	8	3 to 1	3 to 1	.....do....	3.6	.....do........	No work done.
	Reserve:							
10	Section 1.........	8	3 to 1	3 to 1	.....do....	2.8	Stationary....	Do.
11	Section 2.........	8	3 to 1	3 to 1	.....do....	2.1	.....do........	Do.
12	Section 3.........	8	3 to 1	3 to 1	.....do....	2.3	Washing......	Do.
13	Section 4.........	8	3 to 1	3 to 1	.....do....	2.3	.....do........	Do.
14	Section 5.........	8	3 to 1	3 to 1	.....do....	2.3	Stationary....	Do.
	Cornland:							
15	Section 1.........	8	3 to 1	3 to 1	.....do....	2.1	.....do........	Do.
16	Section 2.........	8	3 to 1	3 to 1	.....do....	2.8	.....do........	Do.
17	Section 3.........	8	3 to 1	3 to 1	.....do....	2.5	.....do........	Do.
18	Section 4.........	8	3 to 1	3 to 1	.....do....	3.0	.....do........	Do.
19	Section 5.........	8	3 to 1	3 to 1	.....do....	3.4	.....do........	Do.
	Belle Point:							
20	Section 1.........	8	3 to 1	3 to 1	.....do....	3.0	.....do........	Do.
21	Section 2.........	8	3 to 1	3 to 1	.....do....	2.5	.....do........	Do.
22	Section 3.........	8	3 to 1	3 to 1	.....do....	2.2	Washing......	Do.
23	Section 4.........	8	3 to 1	3 to 1	.....do....	2.3	.....do........	Do.
24	Section 5.........	8	3 to 1	3 to 1	.....do....	2.6	.....do........	Do.

LAKE BORGNE LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	Londerbough:				*Feet.*	*Feet.*	*Feet.*
1	Section 1	1,024	L.	Joseph Hingle............	1,938	1,938	2.0
2	Section 2	1,024	L.	.....do....................	2,250	2,250	2.0
3	Section 3	1,024	L.	.....do....................	1,561	1,540	2.0
4	Fort St. Philip.........	1,040	L.	Michael Cullen...........	678	500	1.5

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.	
	Londerbough:					*Feet.*	*Feet.*	
1	Section 1..........	8	3 to 1	3 to 1	New......	2.4	6.3	Aug. 13, 1903
2	Section 2..........	8	3 to 1	3 to 1	.....do....	2.6	7.0	Do.
3	Section 3..........	8	3 to 1	3 to 1	.....do....	2.8	6.4	Do.
4	Fort St. Philip........	8	3 to 1	3 to 1	Enlargement.	2.1	5.5	Feb. 19, 1904

Fourth district levees, 1903–4—Continued.

LAKE BORGNE LEVEE DISTRICT—Continued.

No.	Name of levee.	Work completed.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
						Least.	Greatest.	Average.	
	Louderbough:			*Cents.*		*Feet.*	*Feet.*	*Feet.*	
1	Section 1	Dec. 23, 1903	14,409.02	17.66	$2,545.59	175	230	200	Making.
2	Section 2	.....do	14,951.15	17.66	2,641.37	170	220	200	Do.
3	Section 3	.....do	12,273.17	17.66	2,521.59	200	290	250	Do.
4	Fort St. Philip....	Apr. 1, 1904	2,170.00	17.97	390.00	105	282	344	Do.

LOWER TENSAS LEVEE DISTRICT.

The amount expended from June 30, 1903, to June 30, 1904, is $101,538.79, distributed as follows:

Office expenses, main office	$1,957.11
Other administrative expenses	3,189.25
Construction of levee (contracts)	87,498.87
Repairs to levees	6,389.70
Surveys	2,064.95
Repairs to plant	204.50
Care of plant	234.41
Total	101,538.79

Money statement.

July 1, 1903, balance unexpended	$24,634.62
Amount allotted from appropriation for maintenance of river and harbor improvement, act of June 13, 1902	110,000.00
	134,634.62
June 30, 1904, amount expended during fiscal year	101,538.79
July 1, 1904, balance unexpended	33,095.83
July 1, 1904, outstanding liabilities	123.75
July 1, 1904, balance available	32,972.08
July 1, 1904, amount covered by uncompleted contracts	15,072.76

ATCHAFALAYA LEVEE DISTRICT.

The amount expended from June 30, 1903, to June 30, 1904, is $21,146.70, distributed as follows:

Office expenses, main office	$969.22
Other administrative expenses	2,069.68
Construction of levees (contracts)	17,107.38
Repairs to levees	22.20
Surveys	225.72
Repairs to plant	384.50
Care of plant	311.75
New plant	56.25
Total	21,146.70

Money statement.

July 1, 1903, balance unexpended	$33,934.60
Amount allotted from appropriation for maintenance of river and harbor improvement, act of June 13, 1902	40,000.00
	73,934.60
June 30, 1904, amount expended during fiscal year	21,146.70
July 1, 1904, balance unexpended	52,787.90
July 1, 1904, outstanding liabilities	170.00
July 1, 1904, balance available	52,617.90
July 1, 1904, amount covered by uncompleted contracts	48,164.83

LAFOURCHE LEVEE DISTRICT.

The amount expended from June 30, 1903, to June 30, 1904, is $26,792.13, distributed as follows:

Office expenses, main office	$569.42
Other administrative expenses	1,525.04
Construction of levees (contracts)	24,077.30
Repairs to levees	39.80
Surveys	196.93
Repairs to plant	146.77
Care of plant	108.79
New plant	69.00
Miscellaneous	59.08
Total	26,792.13

Money statement.

July 1, 1903, balance unexpended	$17,848.64
Amount allotted from appropriation for maintenance of river and harbor improvement, act of June 13, 1902	20,000.00
	37,848.64
June 30, 1904, amount expended during fiscal year	26,792.13
July 1, 1904, balance unexpended	11,056.51
July 1, 1904, outstanding liabilities	82.50
July 1, 1904, balance available	10,974.01
July 1, 1904, amount covered by uncompleted contracts	5,804.87

BARATARIA LEVEE DISTRICT.

The amount expended from June 30, 1903, to June 30, 1904, is $9,305.05, distributed as follows:

Office expenses, main office	$420.26
Other administrative expenses	1,028.16
Construction of levees (contracts)	5,935.79
Repairs to levees	1,163.78
Surveys	757.06
Total	9,305.05

Money statement.

July 1, 1903, balance unexpended	$8,566.03
Amount allotted from appropriation for maintenance of river and harbor improvement, act of June 13, 1902	10,000.00
	18,566.03

June 30, 1904, amount expended during fiscal year	$9,305.05
July 1, 1904, balance unexpended	9,260.98
July 1, 1904, outstanding liabilities	196.34
July 1, 1904, balance available	9,064.64

PONTCHARTRAIN LEVEE DISTRICT.

The amount expended from June 30, 1903, to June 30, 1904, is $64,113.93, distributed as follows:

Office expenses, main office	$380.64
Other administrative expenses	2,273.10
Construction of levees (contracts)	61,153.31
Repairs to levees	15.20
Surveys	291.68
Total	64,113.93

Money statement.

July 1, 1903, balance unexpended	$21,647.05
Amount allotted from appropriation for maintenance of river and harbor improvement, act of June 13, 1902	81,500.00
	103,147.05
June 30, 1904, amount expended during fiscal year	64,113.93
July 1, 1904, balance unexpended	39,033.12
July 1, 1904, outstanding liabilities	172.03
July 1, 1904, balance available	38,861.09
July 1, 1904, amount covered by uncompleted contracts	38,861.09

LAKE BORGNE LEVEE DISTRICT.

The amount expended from June 30, 1903, to June 30, 1904, is $9,935.02, distributed as follows:

Office expenses, main office	$441.14
Other administrative expenses	765.37
Construction of levees (contracts)	8,059.15
Repairs of levees	270.36
Surveys	399.00
Total	9,935.02

Money statement.

July 1, 1903, balance unexpended	$1,821.01
Amount allotted from appropriation for maintenance of river and harbor improvement, act of June 13, 1902	10,000.00
	11,821.01
June 30, 1904, amount expended during fiscal year	9,935.02
July 1, 1904, balance unexpended	1,885.99
July 1, 1904, outstanding liabilities	1,006.57
July 1, 1904, balance available	879.42

Summary of levees built from May 1, 1903, to May 1, 1904.

District.	Earthwork.	Embankment.	Axis of river.
	Cubic yards.	*Linear feet.*	*Linear feet.*
Lower Tensas	455,570.36	33,344	30,[illegible]
Atchafalaya	92,875.56	5,845	7,[illegible]
Lafourche	147,564.65	17,336	16,6[illegible]
Barataria	42,756.85	7,188	6,9[illegible]
Pontchartrain	486,236.12	51,506	52,[illegible]
Lake Borgne	45,803.34	6,430	6,4[illegible]
Total	1,270,806.88	121,649	120,9[illegible]

Statement of yardage of levee work constructed by the United States and others in the fourth district, Mississippi River.

	Levee district.					
	Lower Tensas.	Atchafalaya.	Lafourche.	Barataria.	Pontchartrain.	Lake Borgne.
Aggregate number of cubic yards in levees on the Mississippi River, May 1, 1903	17,947,083	19,411,930	8,125,872	2,879,868	14,578,759	3,402,6[illegible]
Added by the United States up to May 1, 1904	455,570	92,876	147,565	42,757	486,236	45,8[illegible]
Added up to May 1, 1904, by the State and by the district levee boards	586,601	827,830	397,657	134,965	722,253	146,7[illegible]
Total	18,989,254	20,332,636	8,671,094	3,057,590	15,787,248	3,595,2[illegible]
Lost by abandonment, from May 1, 1903, to May 1, 1904:						
By the United States	20,728	51,500	....	9,113	40,800	11,5[illegible]
By the State and others	105,500	116,100	147,200	75,641	245,065	18,9[illegible]
Aggregate remaining on May 1, 1904	18,863,026	20,165,036	8,523,894	2,972,836	15,501,383	3,564,7[illegible]

Percentage of length of existing levee system built wholly or in part by the United States.

Name of district.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Lower Tensas	52.0	59	63	66	72	71.0	71	72	73.0	73.[illegible]
Atchafalaya	43.0	47	68	65	67	68.0	69	68	67.9	68.[illegible]
Lafourche	28.8	54	61	61	62	75.0	82	83	78.0	77.[illegible]
Barataria	19.4	30	43	50	54	63.0	55	55	55.0	[illegible]
Pontchartrain	43.3	63	74	75	77	80.0	78	78	79.0	80.[illegible]
Lake Borgne	18.0	53	60	65	66	44.5	46	46	46.0	44.5

NOTE.—In the Lake Borgne district the percentage had decreased since 1903, on account of the limit of the district having been extended from the upper limits of the United States reservation at Fort St. Philip to Salt Works, an increase in the length of the levee line of 29,884 linear feet.

Percentage of total length of existing levee system, fourth district, improving Mississippi River, built wholly or in part by the United States.

Year.	Percentage.	Year.	Percentage.
1893	13.8	1899	66.[illegible]
1894	26.2	1900	67.2
1895	36.2	1901	68.7
1896	52.0	1902	69.[illegible]
1897	63.0	1903	68.[illegible]
1898	65.0	1904	66.[illegible]

The following maps and appendixes accompany and form part of this report:
Plate I.—Giles Bend revetment.
Plate II.—Giles Bend, bank line.
Plate III.—New Orleans Harbor (Carrollton Bend).
Plate IV.—Bondurant Chute revetment.
Plate V.—Kempe Bend revetment.
Plate VI.—Lower Tensas and Homochitto levee districts.
Plate VII.—Atchafalaya, Lafourche, and Pontchartrain levee districts.
Plate VIII.—Barataria and Lake Borgne levee districts.
Appendix A.—Contracts in force.
Appendix B.—Commercial statistics.
Appendix C.—Report of H. S. Douglas, assistant engineer, on revetment work.
Appendix D.—Report of W. E. Knobloch, superintendent, on levees.

Very respectfully, your obedient servant,

CHAS. S. BROMWELL,
Captain, Corps of Engineers, U. S. Army.

Col. O. H. ERNST,
Corps of Engineers, U. S. Army,
President Mississippi River Commission.

APPENDIX 3 A.

Abstract of contracts in force May 1, 1904, fourth district, improving Mississippi River.

Nature of contract.	Contractor.	Date of approval.	Date of beginning work.	Date of expiration of contract.
Decked barges	J. O. Wright	Emergency	Oct. 31, 1902	Indefinite.
Do	Wm. W. Johnston	Feb. 18, 1904	Feb. 28, 1904	July 1, 1904
Steel hull stern-wheel steamboat.	Chas. P. Willard & Co	Dec. 1, 1903	Dec. 11, 1903	July 15, 1904
Earthwork (levees)	Bobbitt & Linnan	Aug. 24, 1903	July 23, 1903	Mar. 11, 1904
Do	C. H. Whipple	Oct. 2, 1903	Apr. 1, 1904	Jan. 5, 1906
Do	M. L. Linnan	Feb. 5, 1904	Jan. 11, 1904	Sept. 1, 1905
Do	R. T. Clark	Apr. 11, 1903	Mar. 9, 1903	Mar. 1, 1904
Do	Menzies & Co	Mar. 11, 1904	Feb. 1, 1904	Dec. 31, 1904
Do	Jas. R. Marlow	Emergency	Dec. 21, 1902	June 27, 1903
Do	Menzies & Co	do	Dec. 13, 1902	Jan. 25, 1903
Do	do	do	do	Feb. 13, 1903

APPENDIX 3 B.

FOREIGN COMMERCE, PORT OF NEW ORLEANS.

The statistics relating to the foreign commerce of the port of New Orleans were kindly furnished by Hon. Henry McCall, collector of customs:

Vessels.	Entrances.			Clearances.		
	1901-2.	1902-3.	1903-4.	1901-2.	1902-3.	1903-4.
Steam	1,407	1,287	1,173	1,399	1,278	1,167
Sail	92	87	71	79	79	64
Total	1,499	1,374	1,244	1,478	1,357	1,231

Total tonnage of above.

1901-2	3,560,560
1902-3	4,792,547
1903-4	4,271,148

There have been no new lines of transportation established or changes made in existing lines during the period covered by this report.

Exports and imports.

	1902.	1903.	1904.
EXPORTS.			
Total value of exports of foreign merchandise to foreign countries	$2,661,271.00	$2,750,906.00	$595,106.00
Total value of exports of domestic merchandise to foreign countries	132,793,311.00	146,663,388.00	150,174,251.00
Total value of exports of domestic merchandise to Porto Rico	1,919,998.00	2,473,791.00	3,465,982.00
Domestic specie exported to foreign countries	8,300.00	97,550.00	100,950.00
Total	137,382,880.00	151,985,635.00	154,336,289.00
IMPORTS.			
Total value of imports from foreign countries:			
Free	12,809,295.00	15,068,430.00	19,368,413.00
Dutiable	10,154,859.00	13,501,839.00	14,652,151.00
Transit to Mexico	2,104,950.00	1,702,084.00	1,836,042.00
Transported to interior ports	1,893,747.00	3,647,281.00	4,628,639.00
Specie	793,743.00	776,600.00	1,027,590.00
Total	27,756,594.00	34,696,234.00	41,512,835.00
Total duties collected	5,709,313.36	8,954,781.79	8,800,944.20

Appendix 3 C.

REPORT OF MR. H. S. DOUGLAS, ASSISTANT ENGINEER.

New Orleans, La., *May 1, 1904.*

Sir: I have the honor to submit the following report on the works under my local charge from May 1, 1903, to May 1, 1904:

BONDURANT REVETMENT.

At date of last report the bank had been mattressed, graded, and paved for a length of 2,107 feet. The work generally was in good condition, but the upper bank pavement was wrecked in places owing to seepage from Lake Bruen converting the bank into a semifluid, into which portions of the pavement sunk. At a salient point between the work of 1900–1901 and that of 1902–3 the upper bank showed signs of high-water scour. The usual cave at the lower terminus of the revetment had occurred.

The work projected for the season just closed was to extend the revetment about 200 feet farther downstream and to mattress the upper bank at the salient point where high-water scour had occurred. The work planned has been successfully executed.

Itinerary.—Bondurant Chute is a high-water channel, and is not accessible to the plant except at a stage above 26 feet on the Vicksburg gauge. Mattress construction for this work was carried on, in connection with that for Kempe and Giles bends, at Warrenton bar, 10 miles below Vicksburg. Mattresses for Bondurant were commenced December 9 and completed on the 15th. They were built on the bar at a point high enough so that they would not float off until the plant could enter the chute. On March 16 it became evident that there would soon be sufficient water to float the mattresses, and the quarterboat *Delta*, with other necessary plant, was moved from Kempe Bend to Bondurant Chute. On March 17 the mattresses floated off the bar and were towed down the river about 40 miles to the vicinity of the work. The sinking of the mattresses in place was delayed by scarcity of labor, and it was not until March 25 that the work projected was successfully completed.

The detailed cost of the work is given below, except mattress construction, which is reported elsewhere.

Mattress construction: 55,000 square feet, at $0.03239, $1,781.45.

Towing: Tug *General Abbot*, five days, at $24, $120.

Cost per square foot for towing, $0.0022.

Sinking:

Tugs	$276.00
Lumber, wire, wire nails, etc	25.00
475 tons concrete ballast, at $2.032	965.00
Miscellaneous	40.00
Provisions	89.20
Pay rolls	307.27
Total	1,702.47

Cost per square foot to sink, $0.0309.

Cost of mattress in place:

Construction	$1,781.45
Towing	120.00
Sinking	1,702.47
Total	3,603.92

Cost per square foot, $0.0655.

Installation.—This item includes a proportion of the expense of towing the plant from the engineer depot at New Orleans as well as certain fixed expenses from March 1 to 15, while waiting for a sufficiently high stage of water to enable the plant to enter into the Bondurant Chute. They amount to $184.41.

Surveys.—Three cross sections of the chute near the head were located and sounded to obtain a basis for future comparisons as to fill or scour. The bank line above and below the revetment was carefully located. The cost of survey work was $132.

Cost.—The total disbursements for this work from May 1, 1903, to May 1, 1904, were $5,000, distributed as follows:

Construction of mattresses	$1,781.45
Towing of mattresses	120.00
Sinking of mattresses	1,702.47
Installation	184.41
Surveys	132.00
Repairs to plant	208.09
Care of plant	182.32
New plant	130.28
Contingencies and administration	558.98
Total gross cost	5,000.00
Deduct last four items	1,079.67
Total net cost	3,920.33

Summary:

Linear feet of bank protected	338
Linear feet of bank mattressed (subaqueous)	188
Linear feet of bank mattressed (upper bank)	150

The total amount expended for all purposes is $5,000, which, divided by 338, gives $14.80 as the total cost per linear foot of protected bank. Deducting "repairs to plant," "care of plant," "new plant," and "administration and contingencies," the net cost per linear foot of protected bank is found to be $10.10.

Conclusion.—At the close of this report the river is at a high stage, and none of the work can be seen. Its condition is believed to be good. Owing to the mattresses having dried out on the bar before being floated, and to drift lodging under them while sinking, it required over 17 pounds of ballast per square foot to sink them. This, with the small amount of work to be done, the unavoidable delay while waiting for the river to rise, and scarcity of labor, made the cost of this work relatively high. The length of the Bondurant revetment is now 2,295 feet. The work has been successful in preventing further recession of the bank, and appears to have caused the cross section of the chute to diminish and increase the elevation of the bar at its head.

MANUFACTURE OF CONCRETE BALLAST.

This branch of the work was carried on during the past season at Kempe towhead. In the annual reports for 1901-2 and 1902-3 will be found a description of the plant, manner in which operated, kinds and proportions of materials used, and methods of manufacture. During the period covered by this report no material modification of these details has been made, changes being confined to minor improvements in the mechanical portion of the plant.

Itinerary.—The plant left the engineer depot at New Orleans August 12, and arrived at Kempe towhead on the 20th. The manufacture of concrete ballast was begun on August 26. On September 23, after making 2,922 tons of ballast, work was suspended, owing to there being no empty barges available upon which to load the ballast. Operations were resumed on November 27 and continued until January 18, 1904, when the supply of cement on hand was exhausted and work was again suspended. Additional cement was received on January 28, and the manufacture of concrete ballast continued until February 5, 1904, when, after making a total of 7,310 tons, work was suspended for the season.

Cost.—A heavy percentage of the cost of manufacturing concrete is the towing of the plant from the engineer depot at New Orleans to Kempe towhead, about 300 miles upstream. The total amount expended for the manufacture of concrete ballast this season is $14,851.67, subdivided as follows:

2,550 barrels cement, delivered at works	$5,173.07
Labor, superintendence, etc	5,900.91
Services of steamers, tugs, including installation	1,630.10
Care of plant	1,620.59
Repairs to plant	527.00
Total	14,851.67
Total tons of concrete made	7,310
Total cost per ton	$2.032

Deducting the cost for towing the plant from New Orleans, care of plant while it was laid up at Rodney Island, and Kempe bend, and the annual repairs to plant, the field cost per ton of manufactured concrete was $1.737, analyzed as follows:

Cement	$0.708
Supervision	.053
Subsistence	.300
Steamers and tugs	.160
Coal, oil, etc	.063
Operating mixer	.145
Feeding cement to mixer	.027
Wheeling sand and gravel	.140
Tamping concrete in molds	.050
Moving and setting up molds	.091
Average field cost per ton	1.737

Summary:

Total tons (2,000 pounds) concrete ballast made	7,310
Total cost, manufacture of concrete ballast	$14,851.67
Total cost per ton	$2.032
Average field cost per ton	$1.737

Conclusion.—The cost per ton of manufactured concrete, as shown by the figures given, is in excess of last season, the actual field cost per ton being $1.74 as against $1.54 last year. There are several reasons for this, the principal ones being: The very efficient junior engineer heretofore resident on the works was required on other duty and could only give a small portion of his time to the manufacture of concrete ballast; the small amount of ballast made; the unavoidable delays and expense incident to suspension and recommencement of work. The principal employees had to be retained during the periods that work was suspended; and expensive boats charged to concrete manufacture in place of the *Ruby* which had been employed on the work heretofore. On account of the continued cold weather, and the desirability of having the concrete set quickly, the proportion of cement in 1,400 tons was increased from one to sixteen to one to fourteen parts of run-of-the-bar sand and gravel.

IMPROVING ATCHAFALAYA AND RED RIVERS, LOUISIANA.

At date of last report all projected work on the Sill Dams in the Atchafalaya River had been completed.

During the past season operations have been confined to the repair and care of the dredging plant and to the maintenance of the low-water channel through lower Old River between the Mississippi and the Red and Atchafalaya rivers.

On account of favorable conditions, work in pursuance of this latter object has been quite limited. The reason for the favorable conditions was that during low and falling stages the current through Old River was almost uniformly in one direction. During the month of January, 1904, the steamboatmen navigating these waters became apprehensive that the continued fall in the Mississippi would cause the channel of Old River to shoal. The hydraulic dredge *The Ram* belonging to this work was sent there, but during the few days required to get the plant on the ground, the river began to rise and no dredging was found to be necessary.

The plant, and especially the dredging machinery, has been placed in first-class condition. *The Ram* has been used as a towboat on work incidental to bank protection and on jobs connected with levee work.

A careful hydrographic survey has been made throughout the entire length of Old River between the Mississippi and Atchafalaya. This survey develops an increase in section and depth over a period of years. At a plane 35 feet above the zero of Barbres gauge the minimum section in 1894 was 17,692 square feet. In 1903 the area of the minimum section is 19,499 square feet, an increase of 1,807 square feet. In 1894 the minimum depth below the zero of Barbres gauge was 4 feet. In 1903 the minimum depth is 7½ feet, and increase of 3½ feet. Comparisons of mean depth section and depth are as follows:

	Mean section.	Mean depth.
	Sq. ft.	*Feet.*
1894	20,901	26.6
1903	21,809	31.2
Increase	908	4.6

During the period of May 1, 1903, to May 1, 1904, there has been expended on this work the sum of $2,284.80, as follows:

Dredging in Old River	$387.69
Care of plant	197.15
Repairs to plant	1,030.67
New plant	339.55
Miscellaneous	176.87
Administration and contingencies	161.87
Total	2,293.80

So far as is known at the close of this report the condition of the sill dams is good, except that the upstream apron mattress placed last season at Sill Dam No. 3 had been seriously damaged at the east shore end, apparently by a steamboat running into it.

The general condition of the channel through lower Old River has improved, viewed from the standpoint of its maintenance by dredging. The appended table shows the results of the recent survey as compared with those of 1894, 1899, and 1900.

KEMPE BEND REVETMENT.

At date of last report the total length of protected bank in Kempe Bend was 6,330 feet, measured parallel to the general shore line. The river was at a high stage, but so far as was known the work was in good condition.

It was proposed to extend the main revetment about 300 feet downstream and 1,700 feet upstream, but unexpected conditions developed that necessitated almost an entire change of programme.

Early in September, 1903, serious caving of the revetment placed in 1899-1900 occurred, and before the end of the month a considerable portion of the original work placed in 1899 had disappeared. The subaqueous portion of the revetment which failed was only 200 feet wide, the reasons for this being given in the Annual Report for 1900, page 4912. It is doubtful, however, if any kind of subaqueous work at present used in the art of bank revetment would have withstood the strain developed by the extraordinary and unusual conditions prevailing in Kempe Bend during the low water of 1903. Some of these conditions may be briefly outlined, as follows: At about a 40-foot stage on the Vicksburg gauge the width of open waterway at the revetment is 7,200 feet. At zero of the same gauge the width is 915 feet, or 6,285 feet less. When the Vicksburg gauge read 16 feet, the surface slope of the river at the place where the revetment failed was at the rate of over 3 feet to the mile, as determined by levels. Comment is perhaps unnecessary, and the results may be surmised. A comparison of the survey made in 1899, before the revetment was placed, with that made recently, shows that in 1899 there was an extreme depth of 50 feet in the channel at the revetment, whereas in 1903 the extreme depth was over 80 feet. This scour of 30 feet is quite general and amounts to the creation of a new subaqueous bank almost equal in vertical height to the original bank which was mattressed.

As the outcome of the conditions described, the work of the past season in Kempe Bend has consisted of restoring about 2,670 linear feet of mattress which had been partially or wholly destroyed by caving and the placing of 1,400 linear feet of new work opposite the upper wing of the Starling Lopp levee of 1898–99. No grading of the upper bank was done, but the mattress work in the cave between sections 9 and 15 was carried up to about a 20-foot stage. Minor repairs were made to the upper bank pavement over the uninjured portion of the revetment. The salient point at section 6 was regraded and paved. Timber along the bank that was liable to cave in and obstruct future work was felled.

Itinerary.—Operations were commenced September 19, 1903, when the quarterboats *Gamma* and *Delta* were moved to Warrenton bar, about 10 miles below Vicksburg, to build the necessary mattresses. On October 15 the *Gamma* was moved to Kempe Bend and the first mattress sunk October 23. Sinking was continued until January 23, 1904, when work was suspended and the *Gamma* moved to Giles Bend. On February 6, the river having risen to a proper height for placing the upper bank mattresses, the quarterboat *Delta* was moved to Kempe Bend and sinking continued until February 27, when all work was completed.

The usual analysis of the cost of the work is here given.

Mattress construction.—All mattresses for bank revetment at Bondurant, Kempe, and Giles bends, together with 90,000 square feet for New Orleans Harbor, were built at Warrenton bar, about 10 miles below Vicksburg. There were no changes in the character of the work nor in the methods of construction. Nearly all of the work was done by the force on the *Delta*, the *Gamma* assisting on installation. Operations were commenced September 19, 1903, and continued without interruption until January 26, 1904, when 1,352,825 square feet (31 acres) of mattress had been completed for the different works, as follows:

	Square feet.
Bondurant	55,000
Kempe Bend	1,080,265
Giles Bend	127,560
New Orleans Harbor	90,000
Total	1,352,825

The slow and irregular delivery of lumber delayed the work and increased its cost, which was as follows:

Teams, hauling	$7,684.50
Cutting, loading, etc	6,839.53
Privilege of land	264.80
Total	14,788.83

Total cords of willow brush, about	15,000
Cost per cord, delivered at ways	$1.04
Construction:	
14,235 feet B. M., miscellaneous lumber	$188.47
435,137 feet B. M., 2 by 4 inch lumber	5,761.32
299,409 feet B. M., 3 by 6 inch lumber	3,964.18
20,800 pounds 9-inch steel wire nails	506.80
45,200 pounds 6-inch steel wire nails	990.30
5,600 pounds 4-inch steel wire nails	120.40
8,900 pounds No. 10 galvanized wire	228.95

Construction—Continued.

15,000 cords willow brush	$14,788.83
85,000 treenails	153.40
Steamers and tugs	363.00
Miscellaneous	76.51
Provisions	3,667.02
Pay rolls	13,008.82
Total	43,818.00

Total square feet of mattress built	1,352,825
Cost per square foot at ways	$0.03239

In Kempe Bend 1,080,265 square feet were used, valued at $34,989.78.

Towing mattresses.—The distance from Warrenton bar to Kempe Bend is about 60 miles, and the cost for towing the 1,080,265 square feet of mattresses was:

Tug *Genl. Humphreys*, 60 days, at $24	$1,440
Tug *Genl. Humphreys*, 17 days, at $26	442
Steamer *Genl. Newton*, 5 days, at $32	160
Total	2,042

Square feet of mattress towed	1,080,265
Cost per square foot for towing	$0.00189

Sinking.—Beyond the fact that the current in Kempe Bend was even more swift than in past years, and greater power was required to handle the plant and mattresses, there is nothing calling for special remark. A small portion of a mattress was torn off by the current, but this was the only thing approaching to an accident.

Steamers and tugs	$7,410.00
Lumber, wire, wire nails, etc	619.95
5,582 tons concrete ballast, at $2.032	11,342.62
1,487 tons concrete ballast, at $1.08	1,605.96
1,027 tons concrete ballast, at $2.21	2,269.67
Miscellaneous	140.02
Provisions	2,591.98
Pay rolls	9,715.25
Total	35,695.45

Square feet mattress sunk	1,080,265
Cost per square foot to sink	$0.03304

The 1,487 tons of concrete was part of that made in former years on Kempe towhead, and the cost, $1.08, is for breaking up, hauling, and loading. The 1,027 tons, at $2.21, was concrete unloaded last year on the bank to free the barges for high-water emergency work, and the cost of reloading this has been added to the original value.

Cost of mattresses in place:

Construction of mattresses	$34,989.78
Towing of mattresses	2,042.00
Sinking of mattresses	35,695.45
Total	72,727.23
Cost per square foot in place	$0.067

Repairs to upper bank pavement.—Regrading and paving the upper bank at section 6, and minor repairs to existing pavement, cost $458.

Felling timber.—Such trees along the unprotected bank as were liable to cave in and form obstructions to future revetment work were felled and logged at a cost of $78.

Installation.—Owing to the fact that the plant when not in use is cared for at the Engineer Depot in New Orleans, it has to be towed upstream about 300 miles to such places as Kempe when work commences. As a result installation expenses are high, being for this work $1,602.68.

Surveys.—In addition to survey work for the placing and locating of mattress work, the usual detailed hydrographic survey of the bend was made, the total expenditures for this account being $1,277.17.

Cost.—The total disbursements on account of Kempe Bend revetment, from May 1, 1903, to May 1, 1904, were $91,242.92, distributed as follows:

Construction of mattresses	$34,989.78
Towing of mattresses	2,042.00
Sinking of mattresses	35,695.45
Repairs to upper bank pavement	458.00
Timber felling	78.00
Installation	1,602.68
Surveys	1,277.17
Miscellaneous	62.05
Repairs to plant	2,218.16
Care of plant	2,605.30
New plant	2,584.20
Contingencies and administration	7,630.13
Total	91,242.92
Deduct value of material on hand	2,529.00
Total gross cost	88,713.92
Deduct "repairs to," "care of," and "new plant" and "contingencies and administration"	15,037.79
Total net cost	73,676.13

Summary.—There was no upper bank grading or paving done in Kempe Bend this season. In lieu of this the mattress work on the main revetment was carried up to about a half stage of the river.

Linear feet of bank protected	3,760
Linear feet of bank mattressed	3,760

The total cost of the season's work is $88,713.92, giving a gross cost per linear foot of protected bank of $23.60. The total amount expended, less "repairs to plant," "care of plant," and "new plant" and "contingencies and administration," is $73,676.13, giving $19.60 as the net cost per linear foot of protected bank.

Conclusion.—As has been mentioned in previous reports, Kempe Bend revetment is under strain at moderate and low stages of the river. At date of this report the river is at high stage and there is but little current along the revetment. No positive statement as to the condition of the work or its effectiveness can be made until the low water of 1904. There is now 3 detached pieces of revetment in Kempe Bend, respectively, 883, 1,395, and 5,315 feet long, a total of 7,593 feet.

IMPROVING THE HARBORS AT NATCHEZ AND VIDALIA, MISSISSIPPI AND LOUISIANA (GILES BEND REVETMENT).

At date of last report the total length of protected bank in Giles Bend was 14,674 feet, all of which was in good condition.

The funds available for this work during the past season were quite limited and it was proposed to expend them for the maintenance of existing work, which has been done.

In August, after the decline of the flood of 1903, a cave about 300 feet long occurred near the lower end of the revetment. As there had been no scour along the subaqueous work and the upper bank pavement was heavily overlaid with deposit, it is assumed that the cave was caused by an underlying strata of quicksand. The remattressing of this cave, repairing spurs Nos. 1, 12, and 13, and some places in the upper bank pavement, and the felling of timber along the unprotected bank that might cave in and obstruct future revetment constituted the work of the season.

Itinerary.—The mattresses for this work, as well as those for Bondurant and Kempe, were built at Warrenton bar. On January 23, 1904, the quarter boat *Gamma*, with the necessary force and plant, was moved from Kempe to Giles Bend and the sinking of mattresses in the cave, the repairing of spurs and upper bank pavement, and the felling of timber commenced. All of this work was completed by February 9, 1904, except the sinking of a shore mattress in the pocket cave. As it was desirable to have this mattress reach well up the bank, the sinking was delayed until March 26, when the river had risen to a sufficiently high stage. The detailed cost of mattress construction is given elsewhere. That of the other items is analyzed as heretofore.

Mattress construction.: 127,560 square feet, at $0.03239, $4,131.67.

Towing.—All of the mattresses were towed from Warrenton bar to Giles Bend, a distance of about 90 miles.

Tug *Genl. Gillespie*, 5 days, at $27	$135.00
Tug *Genl. Abbot*, 8 days, at $24	192.00
Total	327.00
Square feet of mattress towed	127,560
Cost per square foot for towing	$0.00256

Sinking.—No incident worthy of mention occurred.

Steamers and tugs	$427.00
Lumber, wire, wire nails, etc	55.50
860 tons concrete ballast, at $2.032	1,737.20
Miscellaneous	42.00
Provisions	290.00
Pay rolls	706.85
Total	3,258.55
Square feet of mattress sunk	127,560
Cost per square foot to sink	$0.0260
Cost of mattress in place:	
Construction of mattress	$0.03239
Towing of mattresses	.00256
Sinking of mattresses	.03280
Total cost per square foot in place	.06775

Repairs to pavement.—On account of a sudden rise in the river the amount of repairs made were limited, and the cost was only $40.66.

Timber felling.—Along the unprotected bank, between the upper and lower stretches of revetment, there were a few points where the caving approached the timber. Such trees as were likely to cave in and obstruct future work were felled and logged, at a cost of $24.66.

Surveys.—In addition to the usual routine survey work for locating the mattresses and platting the field charts, the bank line was carefully located by ordinates measured from the base line, and a complete hydrographic survey made over the entire bend, at a cost of $1,277.35.

Installation.—The proportion of installation expenses charged to this work is $350.

Cost.—The total expenditures on account of this work, from May 1, 1903, to May 1, 1904, were $11,449.07, divided as follows:

Construction of mattresses	$4,131.67
Towing of matresses	327.00
Sinking of matresses	3,258.55
Repairs to pavement	40.66
Timber felling	24.66
Installation	350.00
Surveys	1,277.35
Repairs to plant	622.84
Care of plant	231.75
New plant	313.52
Administration and contingencies	871.07
Total gross cost	11,449.07
Deduct last four items	2,039.18
Total net cost	9,409.79

Summary.—The expenditures have resulted in the placing of 127,560 square feet of mattress in the cave near the lower end of the revetment, minor repairs to the upper-bank pavement, felling of timber, and a complete hydrographic survey of the bend.

Conclusion.—As the work of the past season consisted essentially of repairs to existing revetment, a unit of cost is not practicable. The length of revetted bank in Giles Bend is now 14,790 feet, all of which is in fair condition. Considerable caving has occurred along the unprotected portion of the bend, this being marked above spur No. 1. The survey develops scour in the channel, and present indications are that there will be considerable loss of revetment at the ends of existing work before operations are resumed.

NEW ORLEANS HARBOR.

At date of last report the spur dikes and continuous revetment placed on the caving banks in various portions of the harbor were generally in good condition. Some of the spurs in the Gouldsboro Bend are now nearly twenty years old, and it has not been necessary to expend the smallest amount on them for repairs.

Operations planned during the past season were to complete the project of last year, which provided for mattressing the lower bank above the Southport wharf for a length of 1,800 feet with mattresses 250 feet wide, with their inshore edges along the 60-foot contour, and extending the existing revetment for a length of about 4,150 feet below Southport with similarly sized and placed mattresses.

But a small amount of work in pursuance of this project was done last season, the reasons for which were fully set forth in last annual report. During the present season the 1,800 feet of revetment above Southport has been completed, and 3,770 feet of the work below has been placed.

Itinerary.—The mattresses for New Orleans Harbor were constructed at three different places: Fancy Point, just above Port Hickey; the bar at the lower end of Tunica Island, and at Warrenton bar, just below Vicksburg.

On July 29 the quarterboat *Delta* was placed in commission and left the engineer depot at New Orleans in tow of the tug *General Humphreys*. She arrived at Fancy Point and commenced cutting willows and building ways on August 2, 1903. Mattress construction was begun on August 10. The quarterboat *New Orleans* left the engineer depot on August 13 and arrived at Fancy Point on August 15. Mattress construction was pushed with the force on both boats until August 26, when the *Delta* was moved to the bar just below Tunica Island, and on September 6 the *New Orleans* was also transferred to the same locality. Both boats were engaged on mattress construction until September 15, when all the willows on the bar were used up, the quarterboat put out of commission and returned to the engineer depot. On August 29 the first tow of mattresses was brought to New Orleans. Contrary to expectations, based on previous experience in New Orleans Harbor, they silted up very fast, and hurried preparations were made to sink them in proper position to avoid loss. Notwithstanding every effort, one section was lost at its moorings. Fortunately it sunk at a locality where previous caving of the bank made it of some use by reenforcing revetment already in place. On September 22 the first mattress was successfully sunk, and from that time until December 16, when the last mattress was sunk, operations progressed without incident worthy of mention. On December 16 all work practicable with available funds was completed, the plant put out of commission and returned to the engineer depot.

The working season in New Orleans Harbor lasted from July 29 to December 16, a period of one hundred and forty-one days, during which time 1,215,000 square feet of mattress (27$\frac{9}{10}$ acres) were built and towed to New Orleans and 1,200,000 square feet (27$\frac{}{10}$ acres) successfully sunk in place.

Mattress construction.—The usual type of framed mattress was used, constructed in the manner described in previous reports. About 12,660 cords of willow brush were used, cut from 296 acres of land. The weather and river conditions were generally favorable, but the willows had to be hauled a long distance and the prolonged high water had deeply overlaid the bars with deposit which did not dry out, rendering the roads soft and limiting the load that could be hauled. Details are as follows:

Willow brush:

Teams hauling	$7,307.70
Cutting, loading, etc	9,107.10
Privilege of land	296.40
Total	16,711.20

Total cords of willow brush, about 12,660. Cost per cord, delivered at ways, $1.32.

Construction—

58,000 feet B. M. miscellaneous lumber, at $12.40	$719.20
448,976 feet B. M. 2 by 4 inches lumber, at $12.40	5,567.30
160,427 feet B. M. 3 by 6 inches lumber	1,989.27
13,400 pounds 9-inch steel wire nails, at $2.25	301.50
30,000 pounds 6-inch steel wire nails, at $2.15	645.00
8,500 pounds 4-inch steel wire nails, at $2.15	182.75
10,900 pounds No. 10 galvanized wire, at $2.45	267.05
42,000 treenails	100.00

12,660 cords of willow brush, at $1.32	$16,711.20
Steamers and tugs	2,552.00
Miscellaneous	41.34
Provisions	4,648.89
Pay rolls	9,618.60
Total	43,344.10

Square feet of mattress built, 1,215,000. Cost per square foot to build, $0.0356.

Towing.—The mattresses were towed from Fancy Point and Tunica Island, respectively 148 and 175 miles from New Orleans. A small portion of the mattress work, containing 90,000 square feet, was towed from Warrenton Bar, a distance of 350 miles. The largest tow brought down by one boat covered an area of $3\frac{44}{100}$ acres.

Steamer *Ramos*, 27 days, at $36	$972
The Ram, 15 days, at $33	495
Steamer *General Newton*, 29 days, at $32	928
Tug *General Gillespie*, 50 days, at $27	1,350
Tug *General Comstock*, 7 days, at $22	154
Total	3,899

Total square feet of mattress towed, 1,215,000. Cost per square foot for towing, $0.00321.

Sinking.—No quarterboat was available for the force engaged on this work. The cabin of grader No. 5 was used as headquarters for the accommodation of the principal employees and a few laborers. The labor generally was employed by the day, without quarters or subsistence, this being practicable when within the limits of a large city like New Orleans. No doubt some economy resulted, as the cost of sinking was low. It must, however, be considered that ballast on hand and used in New Orleans Harbor costs about one-third less than on other similar works in the district, and that during low water there is but little current and consequently but small expense for steam power to handle the plant and mattresses.

Steamers and tugs	$2,062.00
Lumber, wire, wire nails, etc	466.79
8,409 tons of rock ballast, at $1.35	11,352.15
Miscellaneous	18.58
Provisions	2,169.76
Pay rolls	11,784.72
Total	27,854.00

Square feet of mattress sunk in place, 1,200,000. Cost per square foot to sink, $0.0231.

Cost of mattress in place:

Construction of mattresses	$43,344.84
Towing of mattresses	3,899.00
Sinking of mattresses	27,854.00
Total	75,097.84

Cost per square foot in place, $0.0625.

Surveys.—The usual survey work incidental to placing the mattresses and platting the field chart was supplemented by a detailed hydrographic survey covering all places where work had been done in this harbor. The cost was $1,128.06.

Installation.—The towing of the quarter boats to Fancy Point and Tunica Island and other installation expenses amounted to $403.02.

Cost.—The total cost of the work in New Orleans Harbor from May 1, 1903, to May 1, 1904, is $87,375.39, distributed as follows:

Construction of mattresses	$43,344.84
Towing of mattresses	3,899.00
Sinking of mattresses	27,854.00
Surveys	1,128.06
Installation	403.02
Miscellaneous	78.83
Repairs to plant	1,048.08
Care of plant	1,707.37

New plant	$2,425.40
Administration and contingencies	5,486.79
Total gross cost	87,375.39
Deduct last four items	10,667.64
Total net cost	76,707.75

The total field expenses for the year exceed the expenditures recorded by the office for the same period by $19,947.47. This is explained by the value of material on hand at the beginning of the season, and by the fact that the ballast used had been paid for principally during previous years.

Summary.—The total work of the season was the placing of 1,200,000 square feet ($27\frac{6}{10}$ acres) of mattress in the Southport (Carrollton) Bend, revetting the lower portion of 4,750 linear feet of bank. The gross cost per lineal foot was $18.40, and the net cost $16.15.

Conclusion.—As all work in New Orleans Harbor is at or below low-water mark, and the river is now at a high stage, nothing certain is known of its condition, which is believed to be good. The survey recently completed appears to indicate that the work is serving well the purpose for which it was designed, even that portion of it placed as far back as 1884. A brief history of this work will be found in the annual report for 1897, page 3797.

PLANT.

At date of last report the plant consisted of 49 large pieces. During the year it has been reduced by the condemnation of Grader *No. 3*, the tug *Tilda*, stern-wheel steamboat *Ruby*, and barges Nos. 5, 8, and 9. It has been increased by 5 new standard gunwale barges, of creosoted timber, Nos. 8, 12, 33, 34, and 35, leaving the number of pieces 1 less than last year.

The 5 new barges are part of a contract for 10, entered into last year, on which the contractor has made very slow progress. It is now hoped to have the remaining 5 barges of this contract delivered within the next few months.

Authority to build a new steel hull stern-wheel steamboat, to replace the *Ruby*, was obtained, and a contract for its construction entered into. Fair progress has been made by the contractors, and the delivery of the boat is expected before the forthcoming low-water season.

The construction of 4 more standard barges, of creosoted timber, has been authorized, and contract for their construction made. One of these barges is practically completed, and the early delivery of the remaining 3 is expected.

It has been necessary to move the engineer depot at which the plant is cared for from opposite Audubon Park to a point about 1 mile farther up the river, where a stretch of river front about 1,000 feet in length was obtained from the city of New Orleans. The moving of the large amount of material and property, and the construction of new temporary buildings, sheds, etc., has been an item of considerable expense in the care and maintenance of the plant.

Repairs.—The work of caring for, maintaining, and repairing the plant of the district, has been carried on as heretofore at the engineer depot at New Orleans, La. The following is the work done, in detail:

Tug General Gillespie.—Was docked in commercial dock; 51 rivets were put in plates of hull; the hull outside was thoroughly cleaned and given two coats of coal tar applied hot; the old brass bushing and tail shaft was removed and necessary measurements taken for new stern bearing; tug was then taken out of dock; the stern dock at engineer depot was used when shaft and a new cast-iron bearing were placed in position; a new sleeve was made and shrunk on tail shaft; 5 collars for thrust bearings were refilled with white brass; a new coupling for tail shaft was made and shrunk on shaft; all lost motion was taken out of reversing gear; main throttle valve was taken out, reground, and fitted to seat; 4 new cast-iron packing rings were made and fitted to high-pressure piston valve; all pumps and condenser overhauled, and all leaking tubes repaired; inside of hull cleaned and given two coats of red lead; a new floor in coal bunkers and fireroom put down, and cast-iron floor plates were laid in cement over wooden floor in fireroom; new roof, consisting of No. 6 canvas, given two coats of paint, was put on pilot house and cabin; roof, pilot house, and cabin were painted; in March, 1904, stern dock was put under the tug, broken wheel was removed, and a new wheel fitted to shaft; the rudder post was cut out to make room for a balance rudder, and a new balance rudder was made; 34 boiler tubes were repaired; new bridge walls made, and other minor repairs made to machinery. Cost, $2,123.60.

Tug General Humphreys.—Docked in commercial dock; hull cleaned and given one coat of coal tar applied hot; the wheel and tail shaft were removed, and necessary measurements taken for new stern bearing; tug then taken out of dock; the stern dock at engineer depot was then used, when shaft and wheel were placed back in position; a new sleeve was made and fitted to tail shaft; a new stern bearing was made and fitted in place; two sets of brasses were made for fork end of connecting rod; pins and crosshead turned to fit new brasses; slides were planed on go-ahead side; 2 new brass gibs made; 2 old gibs refaced with copper plates; 2 collars for thrust bearing refilled with white brass; one cast-iron box was made and filled with white brass; the reversing gear was refitted and all lost motion taken up; copper exhaust pipes to main engine repaired; 6 coupling bolts for coupling the shaft were made; auxiliary pump overhauled and repaired; inside of hull cleaned and given two coats of red lead; a new floor was make for bunkers and fireroom; new cast-iron floor plates were laid on cement in fireroom; steering gear repaired; new roof, new facing, and waterway were put on pilot house; deck repaired and calked; inside of kitchen and outside of cabin painted; all auxiliary steam pipes repaired; in August, 1903, the tug returned to depot with broken wheel and rudder, and cracked tail shaft; dock was put under tug; new end was put on shaft, rudder and shoe repaired, and a new wheel put on; slides of main engine were replaned, new gibs made and fitted with white brass and fitted to crosshead; other currrent repairs have been made during the season. Cost, $2,388.39.

Tug General Comstock.—A new wrought-iron trunnion crosshead was forged, finished, and fitted; 2 pairs wrought-iron jaws turned and fitted to crosshead; 4 mild steel bolts fitted to new jaws; turned and fitted 1 new piston rod to piston head; forged and fitted new fork end to connecting rod; 2 pairs of gibs and brasses were fitted to crosshead; 2 new cast-iron slides were made and bolted to frame of engine; crank pin was trued up and brasses fitted to pins; slide valve was faced and valve seat fitted to same; new steel rudder stock was made and fitted to tail shaft; new cast-iron collar and 1 new steel set screw made and fitted to thrust bearing; top of chimney repaired; capstan engine repaired; tug was docked, all large seams and butts calked, and side of hull to water line given a coat of coal tar applied hot; inside of hull cleaned; 26 new deck beams, and entire new deck, fender streaks, chocks, pull bitt, and 1 new set of stern bitts put on; sills under cabin and pilot house repaired; new waterway and nosing put on roof of pilot house and cabin; new roof was put on pilot house and cabin; the old coal bunkers were taken out and new ones put in; new set of fire liners and new brick work was put in furnace; pilot house, inside and outside of cabin, and hull to water line were painted. Cost, $2,014.95.

Tug General Abbot.—Docked; hull cleaned and given two coats of coal tar applied hot; new head was put on stern; deck repaired and calked; new quarters for crew were made in after cabin; guard rail was repaired; the hold was cleaned inside and given two coats of red lead; new sleeve was made and fitted to tailshaft, and new cast-iron bearing was made; rudder post was cut out and new balance rudder, with tiller and ball bearing made; packing of high pressure piston was repaired; crosshead and gibs were repaired, and new sets of brasses made and fitted on either end of same; straps, gibs, and keys were refitted; the crank pin was trued up and new brasses made and fitted to pin; all lost motion was taken out of link; new brasses for go-ahead and go-astern eccentric rods were made and fitted to same; all straps, gibs, and keys were fitted to stub ends.

Thrust bearings were repaired and the old rings were refaced fore and aft; new thrust bolts and nuts were made; keys for same were trued; throttle valve and piston valve were repaired; all lost motion was taken out of reach rods; new valve stem with bracket made for reversing engine; crosshead was repaired and refastened to piston; guide yoke was rebushed; rock-shaft journals were trued up and box for same made with new cap; crank arm was refastened to shaft; lost motion was taken out of connecting hangers and new turned washers and cap bolts furnished; slotted part of cut-off arm was redressed; cut-off block was refitted; cut-off arm was refitted to shaft; brasses were made and fitted to both ends of reach rods; all pins were straightened where bended, and trued up; the handling levers of throttle valve and reversing engine were transferred from starboard to port side of main engine; the circulating pump was fitted with new shaft, and brasses made for both ends; new brasses for both ends of connecting rods were made; new nut and pin for piston were made; crosshead pins were trued and refastened; valve rods were rebushed and pins trued up; heater pipes in heater were repaired; all tubes in the condenser were taken out and new ones put in; all steam pipes were repaired; new steam capstan has been purchased but has not yet been installed; an auxiliary air pump was installed in hold of tug; other minor repairs were made to the tug during the year. Cost, $3,371.78.

Steamer General John Newton.—Two rudder stocks and 1 new rudder were made: 1 rudder repaired; 1 new pair of double bits were made; 400 feet of decking put on deck; 165 feet of plank shear put in on guards; 165 feet of guard rim put on guards; 4 iron cavils put back in place after deck was repaired; 8 new stationary and 8 new swinging fenders were made; a new swinging stage was made; all new deck calked; breeching on boiler, furnace front, and ash pan under boiler repaired; brick work in furnace repaired; all the machinery and steam pipes have been repaired; wheel has been repaired; a new linen locker in cabin was made; the boat was painted inside and out; other minor repairs were made during the year. Cost, $1,657.11.

Dredge The Ram.—A new lignumvitæ bearing was made for cutter shaft; 4 cast-iron shives and 4 steel pins were made for cutter frame; valve seat for priming valve of centrifugal pump was faced; 2 sets of packing rings were made and fitted to pistons of pumping engine; 2 sets of cast iron packing were made and fitted to pistons of propelling engines; discharge pipe of centrifugal pump repaired; new runner and liner were put in centrifugal pump; new shaft and new split coupling were fitted to centrifugal pump; new stub ends were made for small stocks and riveted to shell of boiler; new fire-door liners, grate bars, and bridge walls were put in furnace; 30 feet of new guard rim put on; 8 new swinging fenders were made and put in place; 2 new rudder stocks were made; all rudder irons repaired; a new propelling wheel was made, treated with carbolineum applied hot and given one coat of red lead; inside of hull has been cleaned twice during the year and side of hull and deck cleaned and painted; inside and outside of cabin has been scrubbed; outside of cabin painted; new duplicate parts for the dredging pump were purchased during the year and are now on the boat. Cost, $1,933.16.

Grader No. 5.—A steam capstan taken from condemned Grader No. 3 was installed on Grader No. 5; sheathing on deck repaired; the house and the hull to water line were painted; the hold was cleaned. Cost, $137.09.

Mixer barge and concrete plant.—A new hopper to mixer was made and roof repaired; 4 iron bitts refastened; all iron and wooden mold boards cleaned and repaired; the crown sheet of the boiler was cut out and a new one put in; crank shaft of mixer engine was straightened; new pistons and new packing rings fitted to each engine; the links and link motion was overhauled; 2 new iron pulleys 8 by 18 inches were fitted to shaft of engine and mixer; a new shaft for drum of hoisting engine was made and drum was rebushed and fitted with new friction blocks; new pistons and packing for cylinders were made; cylinder was refastened to bed plates with new and larger bolts; 32 double knives were made and fitted on mixer shafts; a new end was put on end of driving shaft of conveyor; journal boxes were rebabbitted and 4 new idlers made and fitted. Cost, $1,129.40.

Quarterboat New Orleans.—Hull inside was cleaned; 4 graving pieces put in planking of hull; all open seams were gone over by the calkers; 250 feet of plank shear, 250 feet of nosing, and 250 feet of lower plank shear were put on guards; deck repaired and calked; railing on upper deck repaired; 3 new stationary fenders put in; 3 new cavils made and put in place; all blankets washed; bed ticks refitted with excelsior; inside of laborers' quarters scrubbed and disinfected. Cost, $336.85.

Quarterboat Alpha.—Was docked; all the old gunwales and rakes were removed from hull; new gunwales and rakes were put in place; 42 outriggers renewed; new deck put on each end of boat; new guards put on; all guard rims, covering boards, and upper and lower plank shear put on; 4 new bottom plank put in; bottom, sides, and rakes calked; all timber in hull was treated with carbolineum applied hot; dining room in cabin was enlarged; 2 staterooms were enlarged; the boat was painted inside and out; old roof was removed and a new one put on. Cost, $971.73.

Quarterboat Delta.—Guards repaired; 2 new cavils made and bolted in place; 1 iron bitt bolted to deck; deck on each end calked; 4 new carlines put in upper deck and upper deck repaired; roof repaired; floor in kitchen repaired; 2 rows of stanchions put in under deck beams to floor beams; hold cleaned; outside of cabin and inside of rooms and hall painted; ice boxes repaired; a new wash-down closet was installed; 3 new window sashes put in; all bed ticks washed and refilled with excelsior; all blankets washed; 2 closets on deck repaired. Cost, $448.44.

Quarterboat Gamma.—Guards, lower deck and upper deck at each end were repaired; roof given a coat of roofing paint, cooking stoves and stove pipe repaired; water-closets repaired; all blankets and bed ticks washed and ticks refilled with excelsior; in April, 1904, the top sides of gunwales, 10 strakes high on each side, were torn out and new gunwales put in; 35 old outriggers taken out and new ones put in; the ends of 22 carlines repaired; all windows put in on one side; bunks in three sleeping rooms put up in place; 6 graving pieces put in gunwales under outriggers; the hull from water line up was calked; all new gunwales and outriggers were treated with carbolineum applied hot. Cost, $1,395.32.

Barge No. 2.—Docked; 14 floor beams repaired; 800 feet of bottom planking put in; the bottom, rakes, and sides calked; 6 iron bitts were refastened; capstan was taken up, deck renewed, and capstan put back in place; the deck was given a coat of pine tar, then tarred paper was laid and a coat of roofing pitch applied; the deck was then sheathed with 1 by 12 inch planking. Cost, $454.42.

Barge No. 3.—Hold of barge cleaned. Cost, $10.25.

Barge No. 4.—Hold of barge cleaned. Cost, $11.50.

Barge No. 6.—Camel dock was put under each end of barge; 2 rake plank, 3 short pieces and 2 graving pieces put in rakes; rakes and top sides from water line up calked; deck repaired; hold cleaned. Cost, $63.

Barge No. 7.—Camel dock put under each end; 6 rake plank and 4 short pieces of rake plank put in rakes; rakes and top ribs calked; 6 iron bitts refastened to deck; hold of barge cleaned. Cost, $92.

Barge No. 10.—Camel dock was put under one end of barge; 2 pieces of rake plank were put in and rakes calked; 2 iron bitts were refastened; hold cleaned. Cost, $20.75.

Barge No. 11.—Camel dock put under one end of barge, 2 pieces of rake plank put in and rakes calked; hold cleaned. Cost, $20.31.

Barge No. 14.—Sheathing on deck repaired. Cost, $6.

Barge No. 15.—Camel dock was put under the barge twice during the year; 6 rake plank were put in rakes; rakes and two seams above water line were calked; 4 graving pieces were put in rakes; hold of barge was cleaned. Cost, $150.

Barge No. 16.—Sheathing on deck repaired. Cost, $19.50.

Barge No. 17.—Camel dock was put under each end; 6 short pieces of rake plank were put in; rakes and top sides of gunwales were calked; during January, 1904, barge was docked and 150 feet of top gunwales were put in; 100 feet of deck beam clamp were put in under deck beams; 150 feet of covering board were put on deck; iron bitts taken up, 400 feet of decking put down and iron bitts put back in place; sheathing on deck repaired; 250 feet of bottom planking put on bottom; 104 3 by 6 inch stanchions were put in to support the deck; 70 pieces of 4 by 4 inch were put in to support deck beam clamps; 18 rake plank and 4 short pieces of rake plank were put in rakes; 1 corner iron removed, head block repaired and corner iron replaced; 6 iron hatch covers and 1 hatch combing repaired; bottom, sides, and rakes calked; new deck calked; inside of barge cleaned and outside painted. Cost, $457.60.

Barge No. 19.—Docked; 16 rake plank put in rakes; 11 graving pieces put in side of gunwales; outside of barge was sheathed with 2 by 10 inch lumber; 12 gunwale stiffeners 6 by 10 inches by 6 feet by 6 inches were bolted to gunwales; 52 floor beams were repaired with pieces 4 by 8 inches by 11 feet long; two rows of stanchions put under deck beams to floor beams; head block repaired and sheathed; deck repaired and hold cleaned and sides painted. Cost, $622.69.

Barge No. 20.—Camel dock was put under each end; 12 rake plank and 4 short pieces of rake plank put in rakes; head block repaired; ends of gunwales cut off; 2 pieces 6 by 14 inches by 7 feet 6 inches put in rakes and sides calked; during October, 1903, barge was docked and 9 rake floor timbers, 14 rake plank, and 12 gunwale clamps were put in; the barge was sheathed with 2 by 10 inch planking, bolted and spiked to gunwales; all butts of bottom planking, 2 knuckle seams and sides and rakes calked; hold cleaned and outside of barge painted. Cost, $618.58.

Barge No. 21.—Camel docked; 10 rake plank and 4 short pieces of rake plank put in rakes; rakes and gunwales calked to water line; hold cleaned and outside of barge painted. Cost, $103.

Barge No. 23.—Rakes calked; head block repaired and sheathed; 54 deck beams repaired; 72 feet of deck-beam clamp put in, 12 iron bitts were taken up, deck repaired, and bitts replaced; hold cleaned; deck was sheathed with 1 by 6 inch lumber. Cost, $242.47.

Barge No. 25.—Docked; 16 rake plank put in rakes; 7 large graving pieces put in gunwales; 16 6 by 10 inches by 6 feet 7 inches gunwale stiffeners bolted to gunwales; outside of barge sheathed with 2 by 10 inch lumber; bottom, sides, and rake calked; hold cleaned and outside of barge painted. Cost, $485.58.

Barge No. 26.—Camel dock put under each end; 10 rake plank, 2 rake floor timbers, and 52 filling-in pieces put in rakes; rakes and sides calked, hold cleaned, and outside of barge painted. Cost, $136.50.

Barge No. 27.—Each end of all deck beams repaired; all iron bitts taken up, new covering board and deck put down, and bitts replaced; 2 pieces of top gunwales put in; all deck beam clamps repaired; 66 stanchions put under deck beam clamps to support deck. Cost, $145.90.

Barge No 28.—Rakes and sides calked; hold cleaned. Cost, $37.25.

Barge No. 29.—Docked; 1 rake plank and 4 short pieces put in rakes; 108 3 by 4 inch stanchions were put in under deck floor beams to support deck; sheathing of deck repaired; hold of barge cleaned and outside painted. Cost, $186.56.

Barge No. 32.—Rakes of each end calked; sheathing on deck repaired; hold cleaned. Cost, $65.70.

Barge No. 33.—One piece of top gunwale put in; covering board repaired; hold cleaned. Cost, $59.50.

Barge No. 35.—Hold cleaned. Cost, $18.

Warehouse barge.—Deck repaired and calked; 3 iron bitts bolted to deck. Cost, $37.25.

Section dock.—Deck repaired; trunks of docks were repaired and calked; stop waters put in each seam of bulkhead; all pumps have been fitted with new plungers. Cost, $93.70.

Camel dock.—Trunk on one end renewed; other end repaired; trunks and deck calked. Cost, $96.

Survey skiff.—One large survey skiff was made. Cost, $84.34.

Current repairs.—Included under this head are the small jobs incident to the maintenance of the plant in general, and not chargeable to any particular piece. They amounted to $312.86.

Care of plant.—The cost of caring for the plant while not in use, including such items as watching, setting spars, putting out and taking in mooring lines, operating pump boat, expenses of one tug boat, moving property from old to new depot, erecting temporary buildings, general supervision, etc., amounts to $6,051.04.

Condition of plant.—Barges *Nos. 6, 7,* and *24* are beyond economical repair and will shortly become entirely unserviceable. Barges *Nos. 1, 2, 3, 15,* and *17* to *27*, inclusive, are rapidly decaying. Most of them have been sheathed, and with current repairs two or three years' more of service may be obtained from some of them. The hull of the large quarterboat *New Orleans* is in bad condition and beyond economical repair. The remainder of the plant is in very good condition.

Conclusion.—During the year the plant of the district has constructed and placed 56½ acres of mattress and made 7,310 tons of ballast, which bears testimony to its efficiency. A wise policy has been followed of replacing worn-out boats and barges, built of ordinary timber, with hulls either of steel or of wood that has undergone a preserving process. A continuance of this plan must ultimately result in a plant that can be maintained in an efficient condition at a minimum cost.

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Capt. CHAS. S. BROMWELL,
Corps of Engineers.

Table showing comparative sections of lower Old River at a stage of water 35 feet above the zero of Barbres gauge.

Section.	Area.				Width.			
	1894.	1899.	1900.	1903.	1894.	1899.	1900.	1903.
19	23,730	29,212	28,493	24,620	895	895	973	855
20	22,570	26,255	25,136	24,964	825	800	851	823
21	....	....	....	22,415	....	....	....	680
22	21,280	25,905	25,584	28,842	745	750	708	770
23	21,627	26,507	24,170	23,476	710	845	823	775
24	21,925	24,662	22,615	22,952	795	785	781	719
25	21,385	23,730	21,498	23,844	755	745	751	720
26	21,110	22,157	23,079	22,443	780	760	752	730
27	21,787	22,327	22,229	22,868	795	700	722	685
28	20,682	22,457	22,544	....	795	685	723	....
29	21,098	22,415	21,906	21,506	782	750	706	650
30	19,725	22,602	21,409	22,175	830	745	702	670
31	19,900	22,717	21,896	21,433	815	745	740	683
32	19,280	23,072	21,703	21,745	865	740	778	625
33	21,067	22,147	20,178	21,976	785	680	677	680
34	21,090	23,135	23,147	22,054	790	690	694	695
35	21,302	22,332	21,888	21,531	840	705	734	680
36	22,622	23,264	22,462	22,682	840	775	775	685
37	25,037	23,952	24,525	23,851	885	745	742	715
38	....	....	....	23,791	....	....	....	515
39	22,037	22,822	23,108	24,305	680	695	725	720
39½	21,382	21,145	21,404	....	675	665	685	....
40	24,925	20,302	21,146	21,597	615	660	685	680

Table showing comparative sections of lower Old River at a stage of water 35 feet above the zero of Barbres gauge—Continued.

Section.	Area.				Width.			
	1894.	1899.	1900.	1903.	1894.	1899.	1900.	1903.
41	19,772	20,195	20,645	21,057	680	655	677	685
42	19,632	20,412	20,528	22,235	680	625	700	750
43	18,707	20,610	19,868	21,565	655	645	650	650
44	18,395	20,762	21,761	20,917	655	650	643	655
44½	18,707	21,120	22,089	....	675	625	626	....
45	18,967	20,647	23,371	22,107	685	600	629	620
46	19,010	20,747	12,111	21,299	685	660	671	630
47	19,432	20,162	19,842	21,192	670	665	682	690
48	19,587	20,727	20,147	20,858	705	645	704	700
49	20,155	20,700	19,816	22,088	720	695	692	730
50	20,527	20,457	19,300	21,647	730	690	702	730
50½	20,322	20,447	20,541	....	770	730	742	....
51	21,237	20,655	20,287	21,782	860	695	721	725
52	21,027	21,112	20,254	23,485	805	725	732	750
53	20,254	20,907	20,524	22,097	755	713	695	705
54	20,910	20,592	20,246	22,095	755	710	710	705
54½	20,335	19,912	20,423	....	695	650	665	....
55	19,505	20,412	20,628	21,539	695	665	656	665
56	18,697	20,440	20,461	20,073	707	710	742	740
57	20,117	20,177	19,491	20,546	830	715	820	750
58	21,462	22,500	21,171	23,625	870	785	797	795
59	21,857	12,445	19,953	23,528	835	810	827	810
60	21,385	21,567	20,973	20,085	950	805	830	835
61	22,035	21,462	21,354	23,086	855	830	817	810
62	21,197	12,472	19,814	21,974	930	780	824	820
63	20,667	20,332	20,287	20,368	910	740	750	825
63½	21,655	21,615	20,607	....	930	700	785	....
64	20,690	20,980	19,518	21,241	900	755	660	680
65	22,152	19,922	20,532	20,866	890	810	788	720
66	21,022	20,432	18,692	19,499	830	805	690	680
67	21,587	19,862	19,661	20,030	835	780	791	770
68	21,377	21,225	19,753	20,934	960	725	908	765
68½	21,235	19,442	20,035	....	825	715	767	....
69	22,007	20,257	19,882	20,784	860	680	675	765
70	20,977	19,227	19,627	21,691	855	660	729	740
71	23,795	19,707	20,344	20,973	840	690	677	720
72	20,277	21,057	20,390	20,475	725	700	710	700
72½	22,427	21,250	20,559	....	865	690	697	....
73	22,367	19,627	20,746	20,232	890	660	675	675
74	21,240	20,465	20,379	20,027	940	710	760	770
75	20,115	20,305	20,201	20,533	775	615	640	625
76	20,477	21,127	20,841	20,563	755	615	684	640
77	20,072	21,702	21,683	20,668	710	620	622	595
77½	21,197	22,345	21,833	....	830	655	650	....
78	21,855	22,477	20,896	20,625	705	560	581	610
79	19,335	21,930	20,575	21,208	730	555	561	600
80	20,520	25,017	20,238	20,399	930	590	588	605
81	20,417	21,810	21,098	21,330	900	585	587	620
82	21,112	22,107	20,607	20,825	905	565	590	625
83	20,905	19,617	20,662	20,166	800	535	639	585
84	20,710	23,010	20,058	20,089	725	550	602	580
85	21,015	19,505	20,406	20,666	770	585	601	610
86	19,685	22,707	19,890	20,317	830	630	690	575
87	19,992	21,580	21,699	20,917	730	635	695	705
88	20,072	23,505	19,235	20,861	695	700	699	695
89	20,117	20,992	20,163	21,036	705	650	640	675
90	20,342	24,110	20,568	21,222	695	645	625	635
90½	17,692	25,017	23,939	....	735	695	692	....
91	21,290	19,720	20,252	21,210	725	640	642	645
92	....	....	....	23,063	....	....	....	780
93	....	....	....	21,973	....	....	....	685
93½	....	....	....	22,027	....	....	....	715
94	23,992	22,157	21,408	22,540	995	1,110	790	770
95	23,747	21,847	22,625	21,757	1,060	1,050	1,065	790
96	21,175	23,140	21,772	20,871	885	1,015	1,055	705
97	22,960	24,222	21,905	20,610	975	935	975	620
98	22,477	25,190	20,824	19,789	875	875	881	740
99	22,635	23,115	22,192	20,365	875	865	867	690
100	22,565	23,290	22,105	20,245	860	880	875	670
101	21,450	25,180	20,994	22,945	845	840	835	830
102	21,165	21,605	20,383	22,887	770	725	725	740
103	21,107	22,840	20,278	22,373	820	730	740	740
104	21,835	21,267	19,670	22,322	775	790	753	750
105	21,002	21,802	20,620	22,196	795	815	795	800
106	21,220	21,760	20,627	22,701	830	775	772	760
107	20,760	21,270	20,154	22,817	825	730	746	735
108	21,875	21,727	20,619	20,922	850	705	727	730
109	21,732	21,692	20,453	22,268	850	720	745	725
110	20,397	20,872	19,801	21,253	825	745	742	730
111	19,859	20,477	19,945	21,614	810	710	735	715

Table showing comparative sections of lower Old River at a stage of water 35 feet above the zero of Barbres gauge—Continued.

Section.	Area.				Width.			
	1894.	1899.	1900.	1903.	1894.	1899.	1900.	1903.
112	20,102	21,182	19,844	22,059	770	735	692	695
113	20,670	21,257	20,280	21,561	830	775	728	740
114	20,577	22,232	20,683	22,366	765	690	765	660
115	20,070	22,005	20,398	21,289	700	675	647	700
116	19,727	22,102	20,508	21,939	720	695	700	660
117				21,955				670
117½	19,975	21,265	20,672	22,406	750	685	683	690
119	19,345	22,285	20,742	21,223	700	680	687	695
120	19,787	21,320	21,445		750	660	755	
121	19,687	21,550	20,903	21,669	670	680	707	700
122	19,425	21,865	20,014	21,344	655	670	662	695
123	20,805	23,005	21,065		780	785	805	
124	20,787	22,827	20,049	20,737	800	765	787	690
125				21,792				670
126				22,348				625
127	19,840	21,090	18,355	21,673	630	650	623	615
128	18,470	21,905	18,936	21,815	600	650	605	590
129				27,691				680
Total	2,340,922	2,446,422	2,350,836	2,377,110	88,794	80,305	81,234	76,576
Average	20,901	21,843	20,990	21,809	793	717	725	703

Section.	Maximum depth.				Mean depth.			
	1894.	1899.	1900.	1903.	1894.	1899.	1900.	1903.
19	40	45	50	57.7	26.5	32.6	29.3	28.8
20	40	51	56	52.6	27.4	32.9	29.5	30.3
21				55.9				32.9
22	40	52	56	58.8	28.5	34.5	36.1	37.5
23	41	47	54	48.6	30.4	31.4	29.4	32.9
24	40	47	47	46.0	27.6	31.4	29.0	32.3
25	43	47	45	44.8	28.3	31.9	28.6	33.1
26	43	49	47	46.3	27.1	29.2	30.7	30.7
27	42	45	47	44.3	27.4	31.8	30.8	33.4
28	40	48	50		26.0	32.8	31.2	
29	44	50	50	46.0	26.9	29.9	31.0	33.1
30	45	52	50	47.2	23.8	30.3	30.5	33.1
31	45	60	50	48.2	24.5	30.5	29.6	33.9
32	41	52	50	49.3	22.3	31.2	27.9	34.7
33	44	52	50	49.6	26.8	32.6	32.8	32.3
34	44	57	50	49.5	26.7	33.5	33.4	31.7
35	42	53	51	49.2	25.4	31.7	29.8	31.7
36	46	52	53	48.1	26.9	30.0	29.0	32.6
37	51	50	58	48.6	28.3	32.1	33.1	33.3
38				49.2				29.2
39	55	55	49	47.0	32.4	32.9	31.9	33.7
39½	56	49	48		31.7	31.8	31.3	
40	52	50	50	49.4	40.5	30.8	30.9	32.7
41	44	53	55	54.0	29.1	30.8	30.5	30.7
42	44	57	49	49.8	28.9	32.7	29.3	29.6
43	44	59	56	53.7	28.5	31.9	30.6	33.2
44	44	52	60	52.7	27.7	31.9	33.8	31.9
44½	47	61	70		27.7	33.8	35.3	
45	44	54	69	50.5	27.7	34.4	37.2	35.6
46	45	53	54	47.4	27.8	31.4	31.5	33.6
47	45	47	44	46.5	29.0	30.8	29.1	30.7
48	45	45	43	45.8	27.8	32.1	28.6	29.8
49	44	45	42	47.2	28.0	29.8	28.6	30.2
50	45	43	41	46.4	28.1	29.7	27.5	29.6
50½	44	42	41		26.4	28.0	27.7	
51	46	42	41	46.9	24.7	29.7	28.1	30.0
52	44	42	32	46.6	26.1	29.6	27.7	31.2
53	44	43	40	46.5	26.8	29.2	29.5	31.3
54	44	44	41	47.1	27.7	29.0	28.5	31.1
54½	44	40	40		29.3	30.6	30.7	
55	42	41	42	46.3	28.1	30.7	31.4	32.4
56	42	41	44	46.6	26.8	28.9	27.6	27.1
57	43	41	42	47.3	24.2	28.2	23.8	28.1
58	44	43	42	47.2	24.6	28.7	26.6	29.7
59	42	40	41	46.1	26.2	26.5	24.1	29.0
60	46	39	44	46.4	22.5	26.7	25.3	24.0
61	43	39	39	44.6	25.7	25.9	26.1	28.5
62	43	42	42	47.9	22.8	27.5	24.1	26.8
63	46	46	42	48.0	22.7	27.5	27.5	24.7
63½	46	43	42		33.8	30.9	26.2	
64	39	42	44	47.2	23.0	27.8	29.6	31.2
65	40	40	44	50.2	24.9	24.6	26.1	28.9

howing comparative sections of lower Old River at a stage of water 35 feet above the zero of Barbres gauge—Continued.

ection.	Maximum depth				Mean depth.			
	1894.	1899.	1900.	1903.	1894.	1899.	1900.	1903.
....	42	43	45	50.3	25.3-	25.4	27.1	28.7
....	44	45	48	49.8	25.9	25.5	24.8	26.0
....	46	44	47	50.8	22.2	29.3	24.4	27.4
....	45	42	47	....	25.5	27.2	26.1	....
....	45	42	46	47.8	25.6	28.8	29.5	27.2
....	46	43	46	47.9	24.5	29.2	26.9	29.3
....	43	45	48	47.6	28.2	28.6	30.1	28.7
....	46	45	46	47.0	28.0	30.1	28.7	29.2
....	48	50	46	....	25.9	30.8	25.9	....
....	46	47	48	46.1	25.1	29.7	30.7	30.0
....	47	49	50	47.1	22.6	28.8	26.8	26.0
....	44	49	48	47.2	25.9	33.0	31.6	32.7
....	47	55	52	46.6	27.1	34.3	30.3	32.1
....	55	59	54	49.4	28.3	35.0	34.9	34.8
....	44	57	53	....	25.5	33.6	33.6	....
....	58	58	54	51.9	29.2	40.1	36.0	33.7
....	56	58	52	50.6	26.5	39.5	36.7	35.8
....	58	57	55	53.8	22.1	42.4	34.4	33.7
....	55	59	53	55.4	22.5	37.1	35.9	34.4
....	57	56	56	54.3	23.3	39.1	34.9	33.3
....	57	57	54	53.3	26.1	35.4	32.3	34.4
....	60	62	50	53.4	28.5	41.5	33.3	34.6
....	59	49	50	53.9	27.3	32.6	34.0	33.8
....	50	65	43	53.5	23.7	36.1	28.7	35.3
....	47	55	62	52.4	27.0	34.0	31.3	29.6
....	48	54	47	51.0	28.8	33.6	27.5	30.0
....	49	50	45	48.7	28.5	32.3	31.5	31.2
....	50	60	47	50.0	29.3	37.4	32.9	33.4
....	47	51	47	....	24.1	36.0	34.6	....
....	54	45	49	48.4	29.3	30.8	31.5	32.9
....	....	....	....	52.9	....	....	....	29.4
....	....	....	....	48.2	....	....	....	32.1
....	....	....	....	47.9	....	....	....	30.8
....	48	47	44	48.9	24.0	20.0	27.1	29.2
....	43	47	45	46.4	22.4	20.8	21.2	27.5
....	42	48	46	48.3	22.1	22.8	20.6	29.6
....	46	61	33	47.8	23.5	25.9	22.5	33.2
....	51	58	48	50.8	25.7	28.6	23.6	26.7
....	50	53	50	51.3	25.6	26.7	32.3	29.9
....	75	58	50	50.7	26.2	26.5	25.3	30.2
....	48	48	45	52.1	26.5	30.0	25.1	27.6
....	48	50	44	52.9	27.5	29.8	28.1	30.9
....	48	50	43	50.2	25.7	31.3	27.4	30.2
....	48	46	42	48.1	28.3	26.9	26.1	29.7
....	44	45	41	48.2	26.4	26.8	25.9	27.7
....	47	42	40	48.0	25.6	28.1	26.7	29.8
....	46	45	40	47.4	25.2	29.1	27.0	31.0
....	46	50	40	46.0	25.7	30.9	28.4	28.6
....	47	46	43	44.7	25.6	30.1	27.5	30.7
....	48	47	47	46.0	24.7	28.0	26.7	29.1
....	48	50	47	46.2	24.5	29.0	27.1	30.2
....	50	48	46	46.6	26.1	28.4	28.7	31.8
....	48	45	47	45.9	24.9	27.4	27.9	29.1
....	48	54	49	46.4	26.9	32.2	27.0	33.9
....	49	49	46	44.2	28.7	32.6	31.5	30.3
....	46	45	46	47.9	27.4	31.7	29.3	33.2
....	....	....	....	45.3	....	....	....	32.8
....	46	43	43	44.1	26.6	31.0	30.3	32.5
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....	46	50	42	....	26.3	32.3	28.4	....
....	45	45	41	42.5	29.4	31.8	29.6	30.9
....	47	48	41	43.5	29.6	32.6	30.2	30.7
....	50	51	41	....	26.7	29.4	26.2	....
....	52	45	50	44.5	25.9	29.1	23.5	30.0
....	....	....	....	49.3	....	....	....	32.5
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....	48	56	50	52.5	31.5	32.4	29.5	35.2
....	52	61	49	54.2	30.8	33.7	31.3	36.9
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l............	5,246	5,511	5,304	5,344.9	2,977.1	3,451.9	3,283.3	3,401.6
age	46.8	49.2	47.4	49.0	26.6	30.8	29.3	31.2

APPENDIX 3 D.

REPORT OF MR. W. E. KNOBLOCH, SUPERINTENDENT OF LEVEES.

NEW ORLEANS, LA., *May 1, 1904.*

SIR: I have the honor to submit the following report on the levee work that has been done in the Lower Tensas, Atchafalaya, Lafourche, Barataria, Pontchartrain, and Lake Borgne levee districts from May 1, 1903, to May 1, 1904:

Construction.—The river remained at a sufficient elevation to seriously interfere with construction work until the latter part of August, from which time, however, very favorable weather conditions permitted of the prosecution and completion of an unusually large amount of work.

Muck or base ditches.—Where the existing embankment was known or expected to be leaky, and where it was thought objectionable matter might be hidden under the foundations for new levees, muck or base ditches were cut within the base or at the toe of river slope of levee. There were but few cases of this character.

Supervision.—Practically no change has been made in the method of supervision as has been previously reported, and the same general method was continued.

Inspection.—During the year the entire levee line of the fourth district has been inspected by me, accompanied in each district by the general inspector for that district.

Protection against high water.—Up to the date of this report the water has not reached a sufficient elevation to necessitate any protection work.

LOWER TENSAS LEVEE DISTRICT.

The length of the levee line in this district has been increased by the State authorities building 46,380 linear feet of new levee from Union Point (743 R.) to Withlacooche (751 R.). This stretch of levee is not connected with the main line of levee, and a gap of 6.72 miles, from Bougere (738 R.) to Union Point (743 R.), remains unleveed.

The levee system of this district is in good condition as regards grade and section, but within the next few years a large amount of work will be required to maintain the present standard of condition, for the reason that long stretches of levee will fail on account of caving banks. Most of these new levees will be difficult and expensive works, and in order to avoid the heavy expenditure of levee funds that would be rendered necessary by construction during any one year of all new levees required, no more temporary lines should be built, as the life of these temporary levees will in all probability be endangered by unstable banks at about the same time that long stretches of new levee will be necessary.

The building of a new levee by the State authorities at each of the following places, Sycamore (695 R.) and Greens (721 R.), and by the United States at Vaucluse (685 R.), has caused the abandonment of 6,741 linear feet of levee embracing 126,228 cubic yards.

Of the 143.47 miles of effective levee now in this district, there are on May 1, 1904, 508,451 linear feet, or 96.29 miles, built wholly or in part by the United States.

ATCHAFALAYA LEVEE DISTRICT.

Of the incomplete levees under contract at date of last annual report only sections 1 and 4 of Red River Landing levee (766 R.) and section 1 of Smithland levee (767 R.) have been completed.

The construction of a new levee by the State authorities at each of the following places, Irvine (800 R.), Taylor (802 R.), Chapman (804 R.), and Palo Alto (864 R.), and by the United States at Torwood (775 R.) and Lakeside (777 R.), has caused the abandonment of 9,916 linear feet of levee embracing 167,600 cubic yards.

Of the 127.75 miles of effective levee in this district there are, on May 1, 1904, 450,967 linear feet, or 85.4 miles, built wholly or in part by the United States.

LAFOURCHE LEVEE DISTRICT.

Of the incomplete levees under contract at date of last annual report, only sections 1, 2, and 3 of the St. James levee (904 R.) have been completed.

The building of a new levee by the State authorities at each of the following places, Arcadia (896 R.), Welcome (898 R.), Hymelia (928 R.), and Flagtown (937 R.), has caused the abandonment of 5,290 linear feet of levee, embracing 147,200 cubic yards.

Of the 81.92 miles of effective levee in this district on May 1, 1904, there are 335,649 linear feet, or 63.57 miles, built wholly or in part by the United States.

BARATARIA LEVEE DISTRICT.

All work has been completed in this district and there now remain no contracts in force.

The construction of a new levee by the State authorities at each of the following places, Myrtle Grove (1011.5 R.), Magnolia (1011.5 R.), Vacaro (1027.5 R.), Oteri Smith (1028 R.), and Booth (1038.5 R.), and of a new levee at Smith (1037 R.), built by the United States, has caused the abandonment of 84,754 cubic yards.

Of the 71.66 miles of effective levee in this district on May 1, 1904, there are 208,402 linear feet, or 39.46 miles, built wholly or in part by the United States.

PONTCHARTRAIN LEVEE DISTRICT.

Of the incomplete levees under contract at date of last report all have been completed except sections 1, 2, and 3 of Belmont levee (904 L.), sections 1, 2, and 4 of Hester levee (909 L.), and sections 1, 2, and 3 of Angelina levee (917 L.).

The construction of a new levee by the State authorities at each of the following places, Arlington (837 L.), Edgewater (946 L.), Weikling Farm and Perkins (950 and 951 L.), and by the United States at Como (901 L.), Thibodeaux (903 L.), and St. Joseph Church (912 L.), has caused the abandonment of 13,432 linear feet of levee, embracing 285,865 cubic yards.

Of the 125.66 miles of effective levee in this district there are on May 1, 1904, 530,640 linear feet, or 100.50 miles, built wholly or in part by the United States.

LAKE BORGNE LEVEE DISTRICT.

There is now no contract in force for levee construction, all such work having been completed.

The building of a new levee at Louderbough (1024 L.) and those built by the State authorities at Louisiana Store (1010 L.), Fox (1017 L.), Pinaud (1017 L.), and Moran (1038 L.), has caused the abandonment of 12,102 linear feet of levee, embracing 30,410 cubic yards.

Of the 77.01 miles of effective levee in this district on May 1, 1904, there are 179,525 linear feet, or 34 miles, built wholly or in part by the United States.

Abandoned levees.—The following is a table of the previous history of each levee which has been abandoned by the construction of new levees from May 1, 1903, to May 1, 1904:

Name.	Below Cairo.	District.	Length.	By whom built.	When built.	By whom enlarged.	When enlarged.
	Miles.		*Feet.*				
Vancluse	685 R.	Lower Tensas	369 335	United States. Riparian owners.	1892 1866	United States. do	1903 1898
Sycamore	695 R.	do	5,276	Parish and State.	1880	do	1894
Green	721 R.	do	861	United States.	1882	do	1898
Torwood	775 R.	Atchafalaya	1,300	State	1867	State	1899
Lakeside	777 R.	do	1,257	do	1867	do	1899
Irvine	800 R.	do	2,242	do	1867	United States.	1896
Taylor	802 R.	do	1,319	do	1867	do	1896
Chapman	804 R.	do	595	do	1867	do	1896
Palo Alto	864 R.	do	2,287 316	do United States.	1880 1893	State	1897
Arlington	837	Pontchartrain	143 3,726 1,118	do do do	1895 1891 1894	United States.	1899
Como	901 L.	do	1,288	do	1894		
Thibodeaux	903 L.	do	1,058	do	1894		
St. Joseph Church	912 L.	do	1,584	Riparian owners.	[a]	United States.	1897
Weikling Farm	950 L.	do	1,561 110	State	1882	State United States.	1892 1896
Perkins	951 L.	do	241 2,367	do	1892 1882	do	1896

[a] Unknown.

Name.	Below Cairo.	District.	Length.	By whom built.	When built.	By whom enlarged.	When enlarged.
	Miles.		*Feet.*				
Edgewater	946 L.	Pontchartrain	400 225	State	1879	United States	1897
Louisiana Store	1,010 L.	Lake Borgne	550 650	United States	1893 1881	State	1896
Fox	1,024 L.	do	987	Riparian owners.	(a)	do	1900
Pinaud	1,017 L.	do	450	do	(a)	do	1900
Louderbough	1,024 L.	do	6,035	do	(a)		
Moran	1,038 L.	do	3,430	do	(a)		
Arcadia	896 R.	Lafourche	1,245 304	State United States	1881 1893	United States	1896
Welcome	898 R.	do	2,829 1,125	State United States	1880 1892	do	1896
Hymelia	928 R.	do	1,759	State	1891	do	1896
Flagtown	937 R.	do	546	do	1867	do	1899
Myrtle Grove	1,001.5 R.	Barataria	1,410	United States	1893	State	1896
Magnolia	1,011.5 R.	do	1,070	State	1881	United States	1895
Pignola	1,027 R.	do	2,355	Not known		State	1892
Vacaro	1,027.5 R	do	1,024	do		do	1883
Oteri Smith	1,028 R.	do	1,420 2,258	do do		do do	1883 1883
Smith	1,037 R.	do	1,649	do			
Booth	1,038.5 R.	do	450 98 822	State do Not known	1901 1899	 United States do	 1899 1896

a Unknown.

The abandonment of the levee at Vaucluse (685 R.) by the construction of a new levee was not due to a caving bank, but to a salient point which washed badly during the high water of 1903. The levee abandoned by the construction of a new levee at Sycamore (695 R.), was built by the State authorities and by the parish authorities in 1880 and enlarged by the United States in 1894. The cost of the enlargement was much less than ten-twentieths of the cost of the new levee.

The levee abandoned by the construction of a new levee at Green (721 R.), was built by the United States in 1882 and enlarged by the same in 1898. The cost of the enlargement was less than six-twentieths of the cost of the new levee.

The levee abandoned by the construction of new levees at Torwood (775 R.) and Lakeside (777 R.) was leaky and gave trouble during the high water of 1903. These were the reasons for building of new levees, and not on account of caving banks.

Of the 2,242 linear feet of levee abandoned by the construction of a new levee at Irvine (800 R.), 1,842 feet were built by the State authorities in 1867 and 400 feet by the State authorities in 1891. The 400 feet built in 1891 could be of service until 1901, but were thrown out to avoid a long wing and to have a point of juncture with old levee that would have a life of twenty years. The entire 2,242 feet were enlarged by the United States in 1896. The cost of the enlargement was less than eight-twentieths of the cost of the new levee.

The levees abandoned by the construction of new levees at Taylor (802 R.) and Chapman (804 R.) were built by the State authorities more than twenty years ago and enlarged by the United States in 1896. The cost of enlargement per year of service was less than one-twentieth of the cost of the new levee.

Of the 3,203 feet of new levee abandoned by the building of a new levee at Palo Alto (864 R.), 2,887 feet were built by the State in 1880, and 316 feet by the United States in 1893 as a wing of a levee, and were not expected to have a life of twenty years. These 3,203 linear feet of levee were enlarged by the United States in 1897. The cost of enlargement was less than seven-twentieths of the cost of the new levee.

Of the 1,549 linear feet of levee abandoned by the building of a new levee at Arcadia (896 R.), 1,245 feet were built by the State authorities in 1881, and 304 feet by the United States in 1893. The 304 feet built by the United States were built as a wing of a levee and were not expected to have a life of twenty years. The 1,549 feet were enlarged by the United States in 1896. The cost of the enlargement was less than eight-twentieths of the cost of the new levee.

Of the 3,954 linear feet of levee abandoned by the construction of a new levee at Welcome (898 R.) 2,829 feet were built by the State authorities in 1880 and 1,125 feet by the United States in 1892. The location of that portion of the levee built by the United States proved to be an unwise one, as the life of that portion was only twelve years. The enlargement of these lengths by the United States in 1896 was justifiable, the cost thereof being less than eight-twentieths of the cost of the new levee.

The levee abandoned by the construction of a new levee at Hymelia (928 R.) was built by the State authorities in 1891 and enlarged by the United States in 1896. The new levee was not built on account of a caving bank, but to replace that portion of the levee washed away by the crevasse of 1903.

Of the 1,946 linear feet of levee abandoned by the construction of a new levee at Flagtown (937 R.) 546 feet were built by the State authorities in 1867 and enlarged by the United States in 1899. One thousand four hundred and ten feet were built by the United States in 1893 and enlarged by the State authorities in 1898. The cost of enlargement per year of service of the enlarged levee was less than one-twentieth of the cost of the new levee. The location of the 1,125 feet built by the United States was an error in judgement, as the life of this portion of the levee was only twelve years.

The levee abandoned by the construction of a new levee at Myrtle Grove (1001.5 R.) was built by the State authorities in 1881 and enlarged by the United States in 1895. The cost of enlargement per year of service of the enlarged levee was less than one-twentieth of the cost of the new levee.

The date of construction of the new levee abandoned at Magnolia (1011.5 R.) is unknown. The abandoned levee was enlarged by the State authorities in 1892. The cost of enlargement per year of service of the enlarged levee was less than one-twentieth of the cost of the new levee.

Nothing is known of the original construction of the levees abandoned by the construction of new levees at Pignola (1,027 R.), Vacaro (1,027.5 R.), and Oteri Smith (1,028 R.). These levees were enlarged by the State authorities in 1883.

Of the 2,099 feet of levee abandoned by the construction of a new levee at Smith (1,037 R.), nothing is known of the history of the construction of 1,649 linear feet. Four hundred and fifty feet were built by the State authorities in 1901 and had a life of only three years.

Of the 920 linear feet of levee abandoned by the construction of a new levee at Booth (1,038.5 R.), 98 feet were built by the State authorities in 1889 as a wing of a levee and were not expected to have a life of twenty years. These 89 feet were enlarged by the United States in 1899 and the other 822 feet were enlarged by the United States in 1896, but nothing is known of the original construction of this length of levee. The cost of enlargement of both lengths per year of service of the enlarged levee was less than one-twentieth of the cost of the new levee.

Of the 4,987 linear feet of levee abandoned by the construction of a new levee at Arlington (837 L.), 143 feet were built by the United States in 1895, 3,726 feet by the United States in 1891, and 1,118 feet by the United States in 1894. These locations were errors in judgment, as the lives of these levees were less than twenty years. Of these lengths, 1,118 linear feet were enlarged by the United States in 1889. The cost of the enlargement was less than one-twentieth of the cost of the new levee.

The new levees at Como (901 L.) and Thibodeaux (903 L.), were not built owing to recession of the bank but on account of the lack of material on its river side with which to enlarge the old levees. The old levees were built by the United States in 1894.

The levee abandoned by the construction of a new levee at St. Joseph Church (912 L.), was built by riparian owners more than twenty years ago and enlarged by the United States in 1895. The cost of the enlargement of this abandoned levee per year of service of the enlarged levee was less than one-twentieth of the cost of the new levee.

The 625 linear feet of levee abandoned by the building of a new levee at Edgewater (946 L.), were built by the State authorities in 1879. Of this length 225 feet were enlarged by the United States in 1895. The cost of enlargement was less than nine-twentieths of the cost of the new levee.

The 1,671 linear feet of levee abandoned by the construction of a new levee at Weikling Farm (950 L.), were built by the State authorities in 1882. Of the 1,671 linear feet 1,561 feet were enlarged by the State authorities in 1892 and 110 feet by the United States in 1896. The cost of enlargement per year of service of the enlarged levee was less than one-twentieth of the cost of the new levee.

Of the 2,608 linear feet of levee abandoned by the construction of a new levee at Perkins (951 L.), 241 feet were built by the State authorities in 1892 as a wing of a levee, and were not expected to have a life of twenty years. Two thousand three hundred and sixty-seven feet were built by the State authorities in 1882. The 2,608 feet of abandoned levee were enlarged by the United States in 1896. The cost of enlargement was less than eight-twentieths of the cost of the new levee.

Of the 1,200 linear feet of levee abandoned by the construction of a new levee at Louisiana Store (1,010 L.), 550 feet were built by the United States in 1893, and 650 feet by the State authorities in 1881. The location of the portion built by the United States was an error in judgment, as the life of that part of the levee was only eleven years. Both lengths were enlarged by the State in 1895. The cost of the enlargement was less than nine-twentieths of the cost of the new levee.

The date of the construction of the levees abandoned by the construction of new levees at Fox (1,017 L.) and Pinaud (1,017 L.), is not known. These levees were enlarged by the State authorities in 1900. The new levees were not built owing to the recession of the bank, but on account of crevasses.

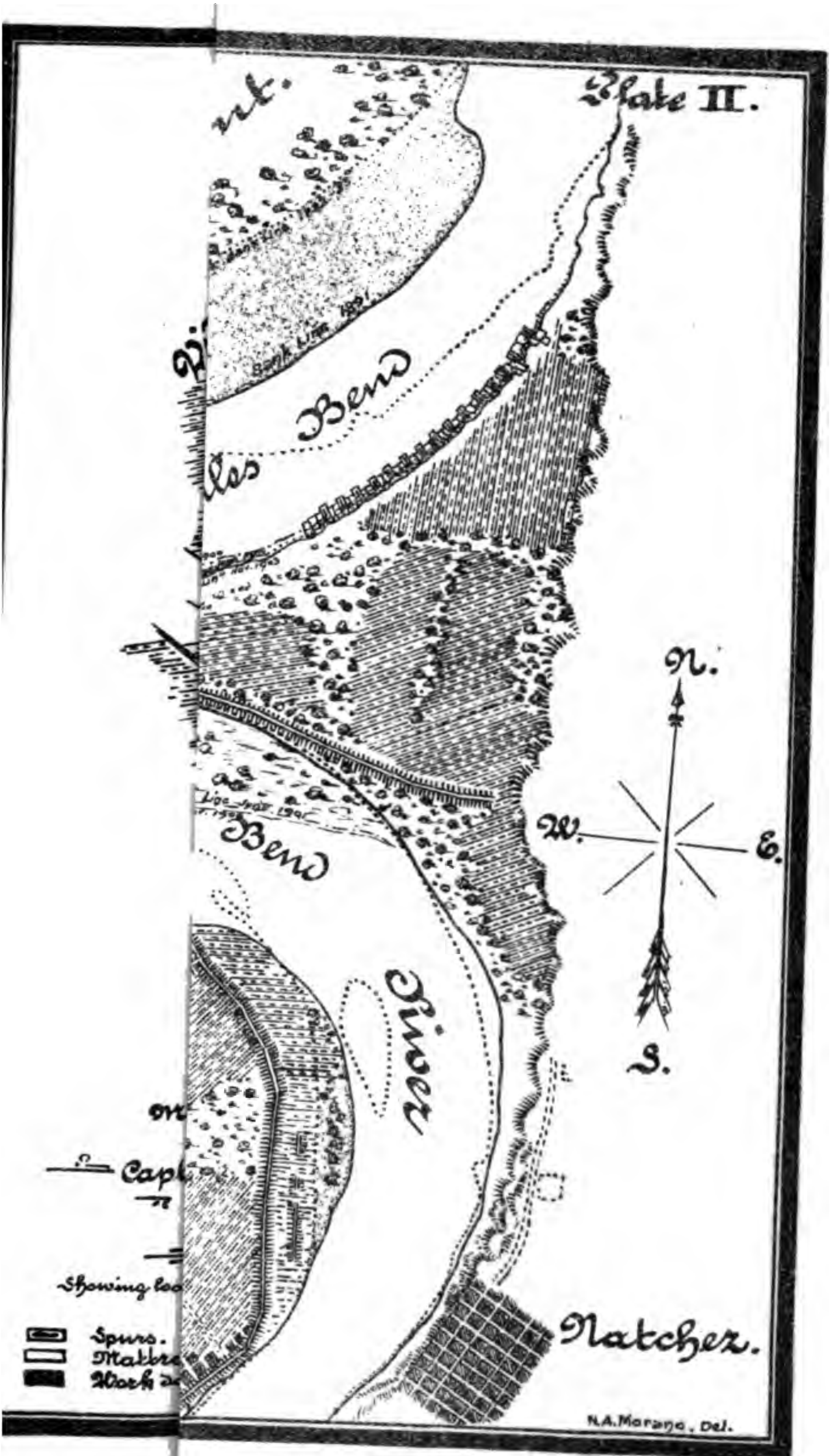
Nothing is known of the history of the construction of the levee abandoned by the building of a new levee at Louderbough (1,024 L.). The new levee was built on account of a crevasse in the old levee.

Nothing is known of the history of the construction of the levee abandoned by the building of a new levee at Moran (1,038 L.). The levee was built at less expense than would have been the cost for enlarging the old levee.

Very respectfully, your obedient servant,

W. E. Knobloch,
Superintendent of Levees.

Capt. Chas. S. Bromwell,
Corps of Engineers.



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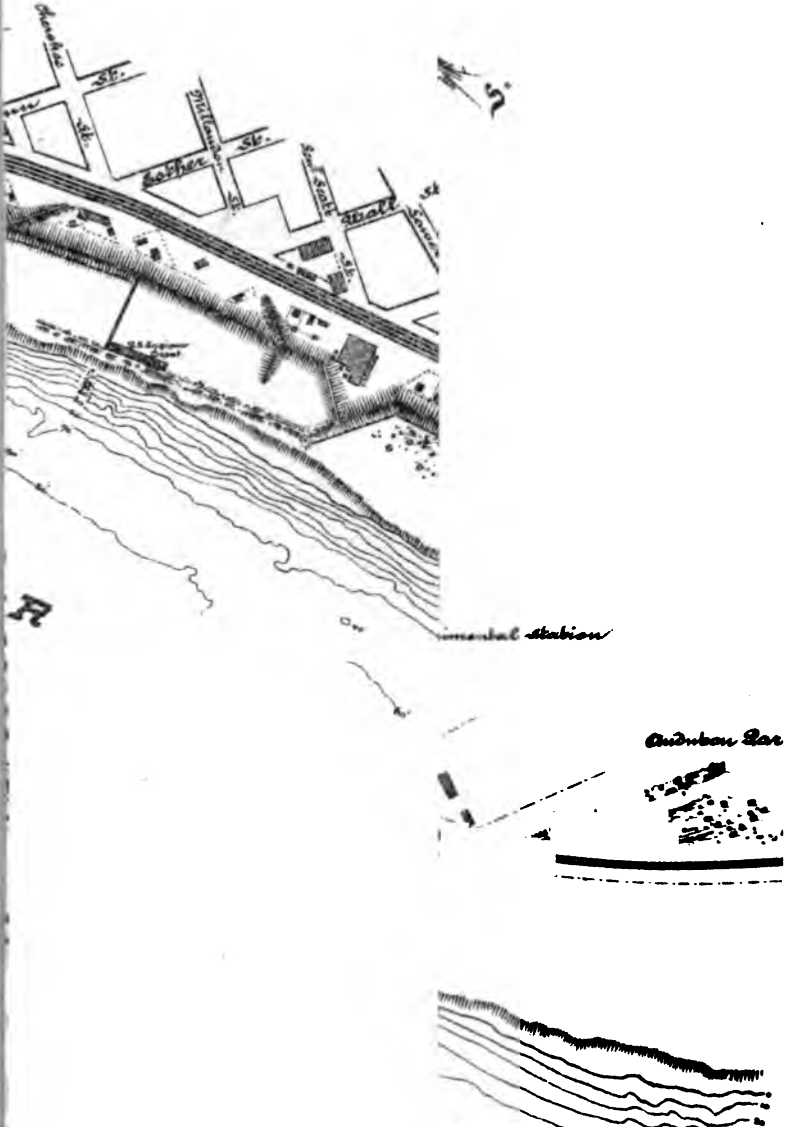Cherokee St.
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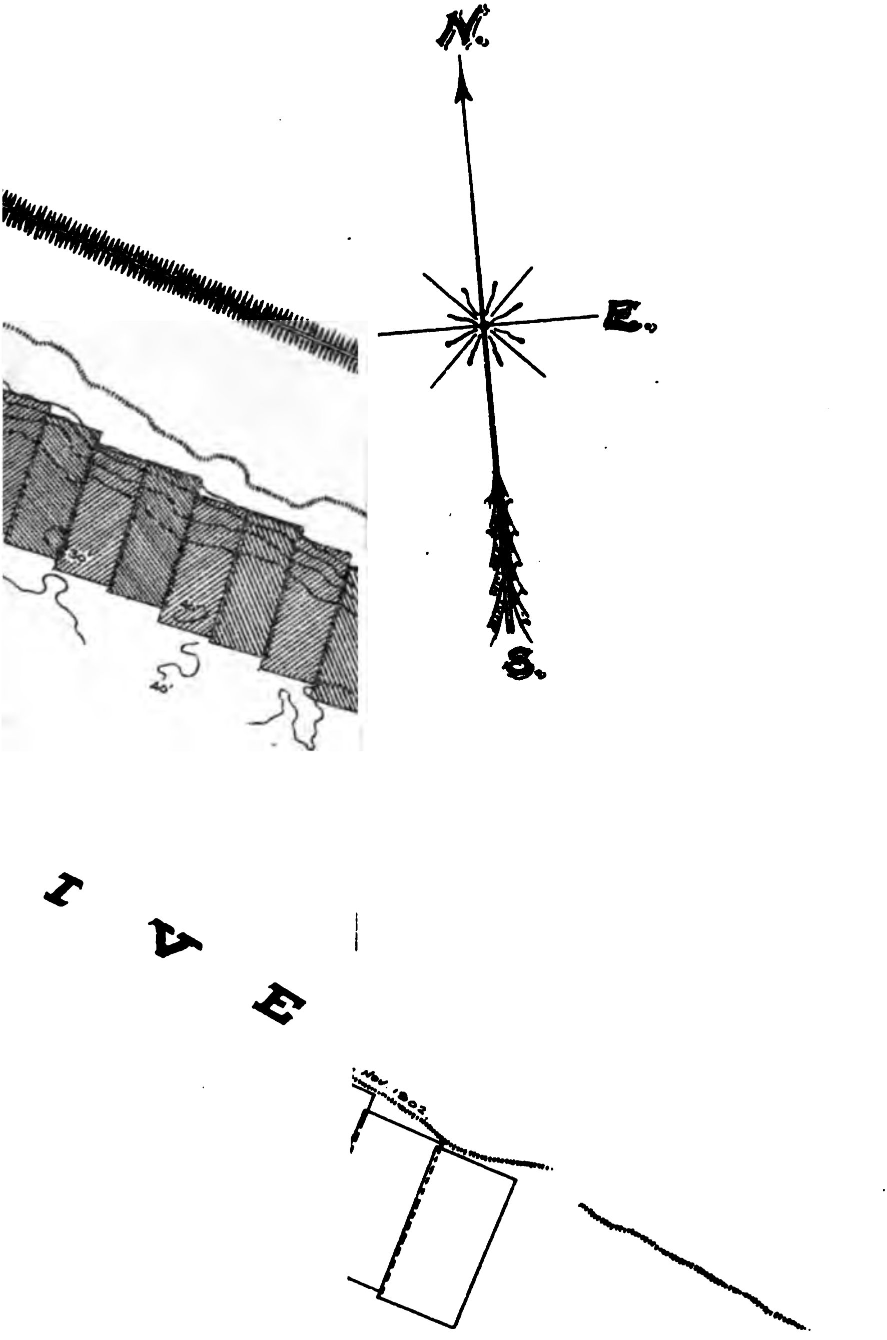

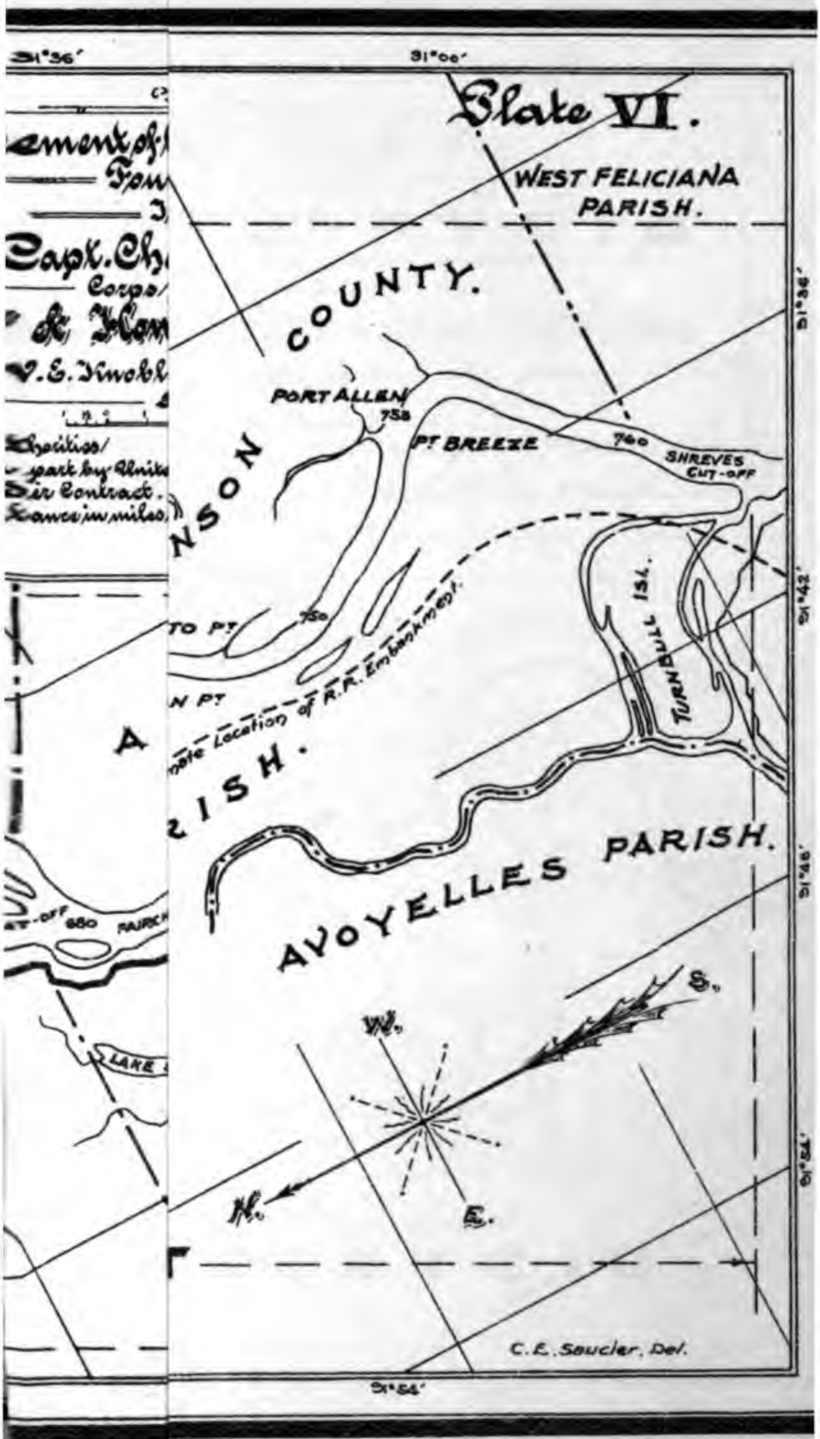
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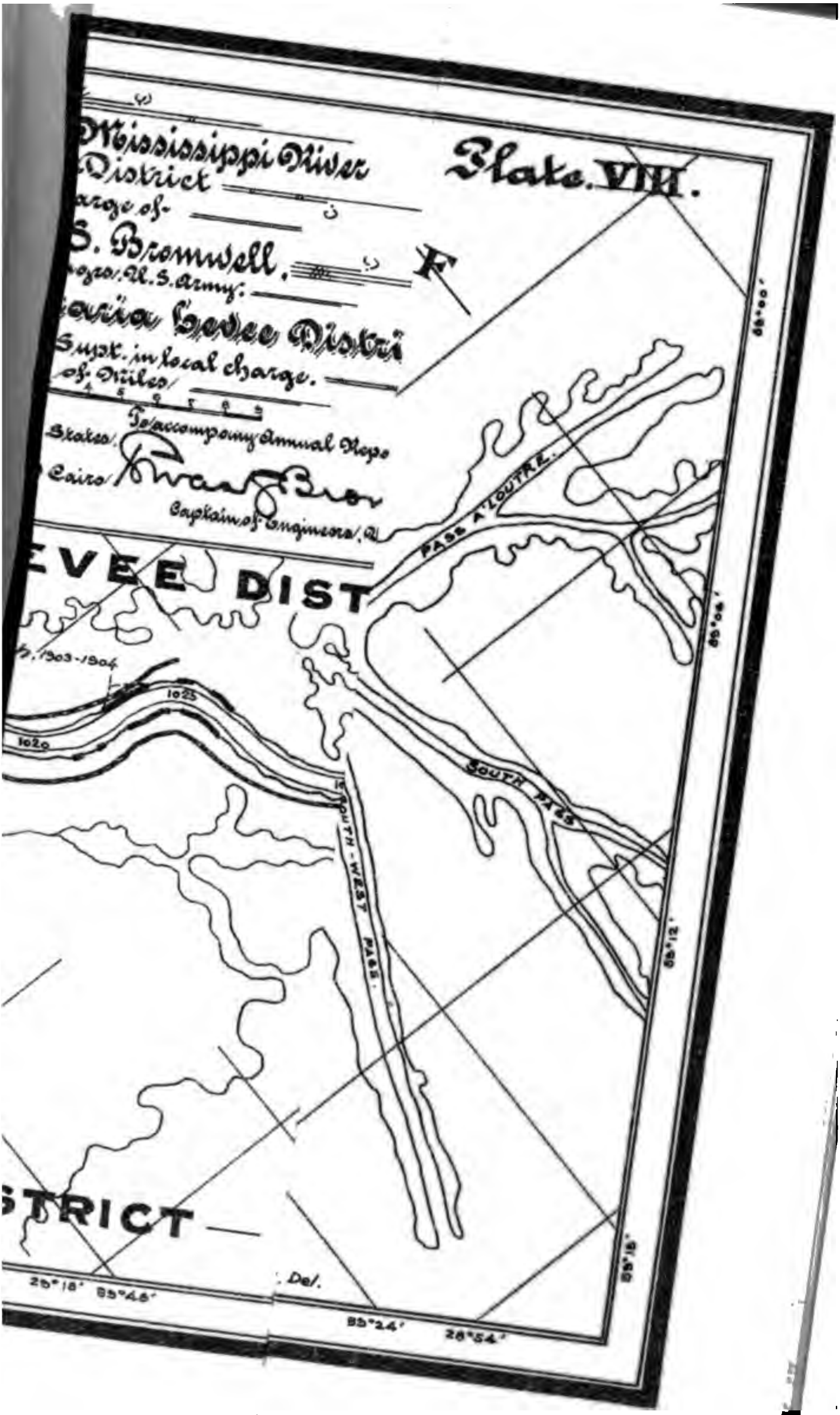Mississippi River
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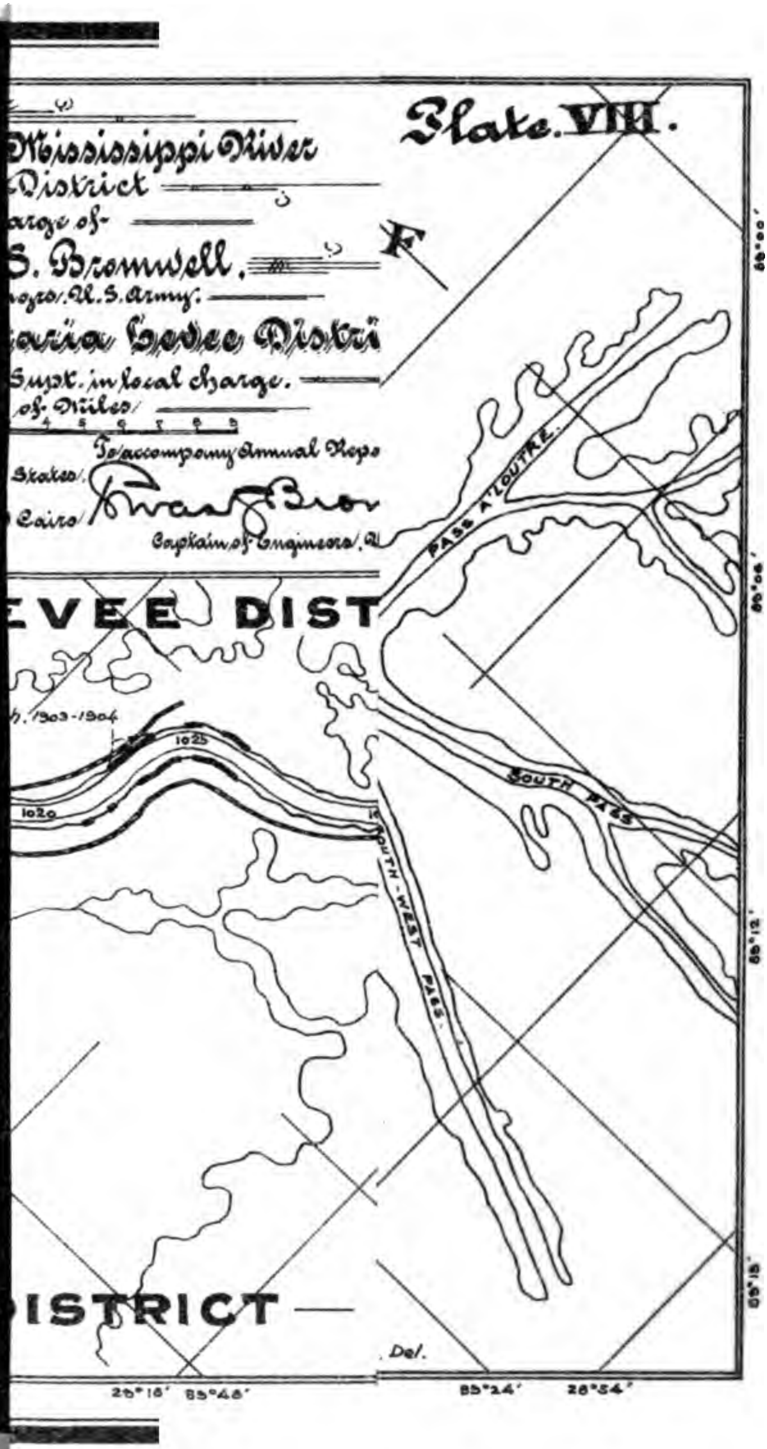
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